The Journal of Parasitology

Volume 25 December Supplement, 1939

PROGRAM AND ABSTRACTS OF THE FIFTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

COLUMBUS, OHIO

DECEMBER 28, 29 and 30, 1939

PROGRAM[1]

THURSDAY MORNING SESSION, DECEMBER 28, 9:30 A.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Read

1. Two New Species of Unusual Strigeid Cercariae from the Douglas Lake Region, Michigan. (12 min) (Lantern) LOUIS OLIVIER, New York University.

2. The Larval Stages of the Gull Strigeid, *Diplostomum flexicaudum,* in Juveniles and Adults of *Stagnicola emarginata angulata.* (15 min) (Lantern) W. W. CORT, Johns Hopkins University, D. B. MCMULLEN, University of Oklahoma, LOUIS OLIVIER, New York University, AND STERLING BRACKETT, University of Wisconsin.

3. Experimental Studies on *Schistosomatium douthitti* (Cort) in Mouse, Rat, Muskrat, Guinea Pig, and Snow-shoe Hare. (8 min) LAWRENCE R. PENNER, University of Michigan Biological Station and University of Minnesota.

4. Development of the Excretory System in Digenetic Trematodes. (15 min) (Also by demonstration) KATHLEEN L. HUSSEY, University of Michigan. (Introduced by GEORGE R. LA RUE.)

5. A Review of the Trematode Superfamily Opisthorchioidea. (15min) (Lantern) EMMETT W. PRICE, U. S. Bureau of Animal Industry.

6. Variation in a New Cestode of the Genus *Raillietina* (*Skrjabinia*) from the Prairie Chicken. (10 min) W. HENRY LEIGH, Wright Junior College, Chicago, Ill.

7. Systems for Designating Hook Pattern in Acanthocephala. (15 min) (Lantern) HARLEY J. VAN CLEAVE, University of Illinois.

8. A Reconsideration of the Acanthocephalan Family Rhadinorhynchidae. (10 min) HARLEY J. VAN CLEAVE, University of Illinois, AND DAVID R. LINCICOME, Tulane University.

9. Notes on the Leeches (Piscicolidae) Living on Fresh-water Fishes of North America. (12 min) (Lantern) MARVIN C. MEYER, University of Kentucky.

10. Geographical Distribution of North American Branchiobdellids. (15 min) (Lantern) CLARENCE J. GOODNIGHT, University of Illinois.

By Title

11. A Cercarial Survey of the Lake Okoboji Region of Iowa. E. L. MILLER, Louisiana State University.

[1] An alphabetical author index will be found at the end of the program. Extra copies of this Supplement will be on sale at the meeting.

12. Studies on Monogenetic Trematodes. III. Redescriptions and Variations in a Few Known Species. JOHN D. MIZELLE, Oklahoma Agricultural and Mechanical College.

13. The Life Cycle of *Cornucopula nassicola* (Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae). JOHN S. RANKIN, JR., Amherst College.

14. Life Cycle Studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae). PAUL V. GUSTAFSON, Whitworth College.

15. Observations on the Life Cycle of *Nudacotyle novicia* Barker, 1916 (Trematoda: Notocotylidae). DONALD J. AMEEL, Kansas State College.

THURSDAY AFTERNOON SESSION, DECEMBER 28, 2:00 P.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Read

16. Development of Trematode Metacercariae into Adult Worms in Sterile Cultures. (15 min) (Lantern) (Also by demonstration) MALCOLM S. FERGUSON, Rockefeller Institute for Medical Research, Princeton, N. J.

17. A New Cultivation Medium and Its Use in the Cultivation of *Nyctotherus cordiformis*. (10 min) E. CLIFFORD NELSON, University of Maine.

18. The Cultivation of *Endamoeba histolytica* without Serum. (5 min) LUCY V. REARDON AND CHARLES W. REES, National Institute of Health.

19. The Microisolation of *Endamoeba histolytica* and Its Cultivation with Single Species of Bacteria. (15 min) (Lantern) (Motion Picture Projector) CHARLES W. REES, National Institute of Health.

20. Some Unusual Variations in Cystic Stages of Intestinal Amoebae. (15 min) (Lantern) D. H. WENRICH, University of Pennsylvania.

21. Quantitative Studies on Avian Malarial Oöcysts. (15 min) (Lantern) CLAY G. HUFF, University of Chicago.

22. Studies on Induced Quartan Malaria in Negro Paretics. II. The Effect of Reversal of the External Conditions upon the Infection. (15 min) (Lantern) MARTIN D. YOUNG, G. ROBERT COATNEY AND TRAWICK H. STUBBS, U. S. Public Health Service, Columbia, S. C.

23. The Development of *Dipetalonema diacantha* and *Dirofilaria spinosa* in Mosquitoes. (12 min) (Lantern) PAUL R. HIGHBY, University of Minnesota.

24. Ticks (*Ornithodoros* spp.) in Arizona Bat "Caves." (8 min) (Lantern) CORNELIUS B. PHILIP, U. S. Public Health Service, Hamilton, Mont.

25. *Hypoderma* Myiasis in the Horse—Summary of a Series of Cases Studied during Spring and Summer, 1939. (10 min) (Lantern) (Also by demonstration) D. W. BAKER AND W. S. MONLUX, New York State Veterinary College.

26. A Study of Winter Activities and Hibernation of *Anopheles quadrimaculatus* in the Tennessee Valley. (12 min) (Lantern) E. HAROLD HINMAN AND H. S. HURLBUT, Tennessee Valley Authority, Wilson Dam, Ala.

27. How Rocky Mountain Spotted Fever Vaccine is Prepared and Used. (By invitation) (30 min) (Motion Picture Projector) CORNELIUS B. PHILIP, U. S. Public Health Service, Hamilton, Mont.

By Title

28. Segmentation in the Internal Organs in Infections with a Mexican Strain of *Plasmodium relictum*. REDGINAL HEWITT, Johns Hopkins University.

29. On the Development of *Nosema bombycis* in the Fall Webworm, *Hyphantria cunea*. R. R. KUDO AND J. D. DECOURSEY, University of Illinois.

30. The Burrowing Owl as a Host to the Argasid Tick, *Ornithodoros parkeri*. WILLIAM L. JELLISON, U. S. Public Health Service, Hamilton, Mont.

31. Siphonaptera: A Study of the Species Infesting Wild Hares and Rabbits of North America North of Mexico. GLEN M. KOHLS, U. S. Public Health Service, Hamilton, Mont.

FRIDAY MORNING SESSION, DECEMBER 29, 9:30 A.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Read

32. The Life Cycle of *Monorcheides cumingiae* (Martin) (Trematoda: Monorchidae). (15 min) (Lantern) (Also by demonstration) W. E. MARTIN, DePauw University.

33. The Life History of *Stichorchis subtriquetrus* (Trematoda: Paramphistomidae). (15 min) (Lantern) HARRY J. BENNETT AND ARTHUR G. HUMES, Louisiana State University.

34. Life History Studies on Monostomes of the Genus *Notocotylus* (Trematoda). (10 min) (Lantern) ELMER C. HERBER, Dickinson College.

35. The Life Cycle of *Euparyphium melis* (Trematoda: Echinostomidae). (5 min) (Lantern) PAUL C. BEAVER, Lawrence College.

36. Studies on *Clinostomum.* VI. The Penetration and Post-cercarial Development of *Clinostomum marginatum* (Rud.). (15 min) (Lantern) GEORGE W. HUNTER, III AND WANDA S. HUNTER, Wesleyan University, AND EMIL KOTCHER, Johns Hopkins University.

37. Life Cycle of *Corallobothrium* sp. from *Ameiurus nebulosus.* (10 min) (Lantern) JOHN E. LARSH, JR., University of Illinois.

38. Preliminary Investigations on the Life Cycle of a Cestode of the Mouse, *Mus musculus.* (10 min) (Lantern) (Also by demonstration) ROBERT C. RENDTORFF, University of Illinois.

39. Further Studies on the Life Cycle of a Cestode from the Herring Gull. (15 min) (Lantern) (Also by demonstration) LYELL J. THOMAS, University of Illinois.

FRIDAY MORNING, DECEMBER 29, 11:15 A.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Presidential Address

40. Life History Studies and the Development of Parasitology. HORACE W. STUNKARD, New York University.

FRIDAY NOON, DECEMBER 29.

12:30 PARASITOLOGISTS' LUNCHEON, ROOM 309, POMERENE HALL, OHIO STATE UNIVERSITY, for members and guests.

1:30 ANNUAL BUSINESS MEETING.

FRIDAY AFTERNOON SESSION, DECEMBER 29, 3:00 P.M.; HAMILTON HALL, OHIO STATE UNIVERSITY. (Tea will be served.)

By Demonstration

4. Development of the Excretory System in Digenetic Trematodes. (Also read) KATHLEEN L. HUSSEY, University of Michigan. (Introduced by GEORGE R. LA RUE.)

16. Development of Trematode Metacercariae into Adult Worms in Sterile Cultures. (Also read) MALCOLM S. FERGUSON, Rockefeller Institute for Medical Research, Princeton, N. J.

25. *Hypoderma* Myiasis in the Horse—Summary of a Series of Cases Studied during Spring and Summer, 1939. (Also read) D. W. BAKER AND W. S. MONLUX, New York State Veterinary College.

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38. Preliminary Investigations on the Life Cycle of a Cestode of the Mouse, *Mus musculus.* (Also read) ROBERT C. RENDTORFF, University of Illinois.

39. Further Studies on the Life Cycle of a Cestode from the Herring Gull. (Also read) LYELL J. THOMAS, University of Illinois.

41. A Method of Obtaining Clean Suspensions of Cysts of *Endamoeba histolytica* from Culture. HENRY E. MELENEY AND THOMAS L. SNYDER, Vanderbilt University.

42. *Glugea microspora*, a New Microsporidian Species from the Liver of the Sand-eel, *Amnodytes lanceolatus*. LOUIS VAN DEN BERGHE, Institut Prince Leopold, Antwerp, Belgium.

43. The Effects of Monochromatic Ultraviolet Radiation on Eggs of *Enterobius vermicularis*. MYRNA F. JONES, LEON JACOBS AND ALEXANDER HOLLAENDER, National Institute of Health.

44. Demonstration of Ultraviolet Microscopy. PETER A. COLE AND F. S. BRACKETT, Washington Biophysical Institute and National Institute of Health. (Introduced by ELOISE B. CRAM.)

45. Further Studies on the Life Cycle of *Leptorhyncoides thecatus*. D. L. DEGIUSTI, University of Michigan Biological Station and University of Wisconsin.

46. The Anatomy of the Linguatulid, *Kiricephalus coarctatus* (Diesing) Sambon, 1910. CARL E. VENARD, Ohio State University.

47. Demonstration of a Species of Marine Piscicolidae from Florida. MARVIN C. MEYER, University of Kentucky.

48. The Glycogen Distribution in the Body of Acanthocephala. THEODOR VON BRAND, Barat College of the Sacred Heart, Lake Forest, Ill.

49. Studies on the Life History of a Parasitic Copepod, *Lernaea carassii*. WILBUR M. TIDD, Ohio State University.

50. *Dioctophyme renale*, the Giant Kidney Worm Occurring in Mink, from the Southern Counties of Michigan. ARTHUR E. WOODHEAD AND CHARLES W. MCNEIL, University of Michigan.

51. Effect of Age of Rat on the Size of *Trichinella* Infections. E. H. MARCHANT, State University of Iowa. (Introduced by L. O. NOLF.)

52. Sex Ratio of *Trichinella spiralis* from the Digestive Tract of Rats. O. F. GURSCH, State University of Iowa.

53. Recovery of *Trichinella spiralis* Larvae from Early Stages of Infection. ARTHUR J. LEVIN, State University of Iowa. (Introduced by L. O. NOLF.)

54. Schistosome Dermatitis: Distribution and Epidemiology in Michigan. DONALD B. MCMULLEN, PAUL F. REZIN AND LEONARD ALLISON, University of Oklahoma and Michigan Stream Control Commission.

55. Seasonal Variation in Emergence of Cotylocercous Cercariae. CHARLES G. DOBROVOLNY, University of Michigan.

56. Digenetic Trematodes of Fishes of the Galapagos Islands and Their Relationships. HAROLD W. MANTER, University of Nebraska.

57. *Diplostomum fosteri* n. sp. from a Panama Otter, *Lutra repanda* Goldman. ALLEN MCINTOSH, U. S. Bureau of Animal Industry.

58. Experimental Infection of European Starling with *Leucochloridium carus*. ALLEN MCINTOSH AND GERTRUDE E. MCINTOSH, U. S. Bureau of Animal Industry.

59. The Life History of *Spelotrema nicolli* (Trematoda: Microphallidae). R. M. CABLE AND A. V. HUNNINEN, Purdue University, Oklahoma City University and The Marine Biological Laboratory.

60. Studies on the Life History of Colorado Trematodes. WILEY W. CRAWFORD, Blackburn College.

61. Life History of *Triganodistomum mutabile* (Cort): Trematoda. HAROLD E. WALLACE, University of Michigan. (Introduced by GEORGE R. LA RUE.)

62. Development of the Excretory System in *Cercariaeum mutabile* (Cort): Trematoda. HAROLD E. WALLACE, University of Michigan. (Introduced by GEORGE R. LA RUE.)

63. Life History of *Caecincola parvulus* Marshall and Gilbert (Trematoda: Heterophyidae). WALTER S. LUNDAHL, University of Michigan. (Introduced by GEORGE R. LA RUE.)

64. Life History of *Spirorchis* sp. (Trematoda: Spirorchidae). LIMAS D. WALL, University of Michigan. (Introduced by GEORGE R. LA RUE).

65. The Life History of an Apharyngeal Strigeid Trematode from Douglas Lake, Michigan. LOUIS OLIVIER, New York University.

72. Allergic Skin Reactions in Human *Echinococcus* Infection with Antigens from Related Taenias. (Also read) JAMES T. CULBERTSON AND HARRY M. ROSE, College of Physicians and Surgeons, Columbia University.

74. Immunity to Hookworm (*Bunostomum phlebotomum*) and Nodular Worm (*Oesophagostomum radiatum*) Infection in Calves. (Also read) ROY L. MAYHEW, Louisiana State University.

SATURDAY MORNING SESSION, DECEMBER 30, 9:30 A.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Read

66. Immunization of Birds to Malaria by Vaccination. (10 min) (Lantern) W. B. REDMOND, Emory University.

67. The Protective Action of Immune Serum against *Plasmodium lophurae* in Chickens. (15 min) (Lantern) W. H. TALIAFERRO AND LUCY GRAVES TALIAFERRO, University of Chicago.

68. The Reaction between Hookworm, *Ancylostoma caninum*, Larvae and Immune Serum. (15 min) (Lantern) G. F. OTTO, Johns Hopkins University.

69. On the Transmission of Immunity to *Trichinella spiralis* from Parent to Offspring. (10 min) (Lantern) EVELYN ABRAMS MAUSS, Brooklyn College.

70. Length of Life of Singly-Established *Strongyloides ratti*. (15 min) (Lantern) GEORGE L. GRAHAM, Rockefeller Institute for Medical Research, Princeton, N. J.

71. On the Nature of Age Resistance to *Strongyloides ratti*. (15 min) (Lantern) HARRY J. LAWLER, Johns Hopkins University.

72. Allergic Skin Reactions in Human *Echinococcus* Infection with Antigens from Related Taenias. (15 min) (Lantern) (Also by demonstration) JAMES T. CULBERTSON AND HARRY M. ROSE, College of Physicians and Surgeons, Columbia University.

73. The Intestinal Phase of the Immunity to *Cysticercus pisiformis* in Rabbits. (12 min) (Lantern) A. BYRON LEONARD AND ALICE E. SMITH, University of Kansas.

74. Immunity to Hookworm (*Bunostomum phlebotomum*) and Nodular Worm (*Oesophagostomum radiatum*) Infection in Calves. (15 min) (Also by demonstration) ROY L. MAYHEW, Louisiana State University.

By Title

75. Serological Reactions of Some Helminths. RAYMOND W. WILHELMI, New York University. (Introduced by HORACE W. STUNKARD.)

SATURDAY AFTERNOON SESSION, DECEMBER 30, 2:00 P.M.; ROOM 205, ORTON HALL, OHIO STATE UNIVERSITY.

Read

76. Experimental Human Infection with *Sparganum mansonoides* (Mueller, 1935). (15 min) (Lantern) JUSTUS F. MUELLER AND FRED GOLDSTEIN, New York State College of Forestry.

77. A New Record of Human Heartworm Infection, from New Orleans. (10 min) (Lantern) ERNEST CARROLL FAUST, Tulane University.

78. Studies of the Survival of Eggs of *Enterobius vermicularis* under Known Conditions of Humidity and Temperature. (10 min) (Lantern) MYRNA F. JONES AND LEON JACOBS, National Institute of Health.

79. The Blood Picture of White Mice Infected with *Trichinella spiralis*. (10 min) (Lantern) GEORGE W. HUNTER, III AND VINCENT GROUPÉ, Wesleyan University.

80. The Penetration of Radioactive Phosphorus into Encysted *Trichinella* Larvae. (10 min) (Lantern) O. R. McCoy and Vincent Downing, University of Rochester.

81. A Practical Plan for the Control of Trichinosis. (10 min) (Lantern) T. C. Nelson, Rutgers University.

82. Progress Report on Pasture Rotation and the Prevalence of the Helminth Parasites of Sheep in Southwest Virginia. (10 min) (Lantern) W. L. Threlkeld, Virginia Agricultural Experiment Station.

83. Phenothiazine as an Anthelmintic. (15 min) Paul D. Harwood, Robert T. Habermann and Leonard E. Swanson, U. S. Bureau of Animal Industry.

84. Changes Occurring in Blood of Chickens during Cecal Coccidiosis. (10 min) (Lantern) C. A. Herrick, University of Wisconsin.

85. The Effect of Sulfapyridine on Experimental Avian Coccidiosis. (7 min) (Lantern) P. P. Levine, New York State Veterinary College.

86. *Capillaria* Infection of the Lower Digestive Tract of the Common Fowl (*Gallus domesticus*). (10 min) Neal F. Morehouse, Dr. Salsbury's Laboratories, Charles City, Iowa.

By Title

87. Actual State of Human Hepatic Distomosis in Cuba. Pedro Kourí and José G. Basnuevo, Institute of Tropical Medicine, University of Havana.

88. Studies on the Bovine Blood Picture in Hookworm (*Bunostomum phlebotomum*) and Nodular Worm (*Oesophagostomum radiatum*) Infections. Elaine T. Delaune and Roy L. Mayhew, Louisiana State University.

89. Anthelmintic Efficacy of Unconditioned Crude Phenothiazine. Robert T. Habermann and Paul D. Harwood, U. S. Bureau of Animal Industry.

AUTHOR INDEX

Showing program number, which is also abstract number of each paper.

Author	*Program & Abstract Number*	*Author*	*Program & Abstract Number*
Allison, Leonard	54	Levine, P. P.	85
Ameel, Donald J.	15	Lincicome, David R.	8
Baker, D. W.	25	Lundahl, Walter S.	63
Basnuevo, José G.	87	Manter, Harold W.	56
Beaver, Paul C.	35	Marchant, E. H.	51
Bennett, Harry J.	33	Martin, W. E.	32
Brackett, F. S.	44	Mauss, Evelyn Abrams	69
Brackett, Sterling	2	Mayhew, Roy L.	74, 88
Cable, R. M.	59	McCoy, O. R.	80
Coatney, G. Robert	22	McIntosh, Allen	57, 58
Cole, Peter A.	44	McIntosh, Gertrude E.	58
Cort, W. W.	2	McMullen, D. B.	2, 54
Crawford, Wiley W.	60	McNeil, Charles W.	50
Culbertson, James T.	72	Meleney, Henry E.	41
DeCoursey, J. D.	29	Meyer, Marvin C.	9, 47
DeGiusti, D. L.	45	Miller, E. L.	11
Delaune, Elaine T.	88	Mizelle, John D.	12
Dobrovolny, Charles G.	55	Monlux, W. S.	25
Downing, Vincent	80	Morehouse, Neal F.	86
Faust, Ernest Carroll	77	Mueller, Justus F.	76
Ferguson, Malcolm S.	16	Nelson, E. Clifford	17
Goldstein, Fred	76	Nelson, T. C.	81
Goodnight, Clarence J.	10	Olivier, Louis	1, 2, 65
Graham, George L.	70	Otto, G. F.	68
Groupé, Vincent	79	Penner, Lawrence R.	3
Gursch, O. F.	52	Philip, Cornelius B.	24, 27
Gustafson, Paul V.	14	Price, Emmett W.	5
Habermann, Robert T.	83, 89	Rankin, John S., Jr.	13
Harwood, Paul D.	83, 89	Reardon, Lucy V.	18
Herber, Elmer C.	34	Redmond, W. B.	66
Herrick, C. A.	84	Rees, Charles W.	18, 19
Hewitt, Redginal	28	Rendtorff, Robert C.	38
Highby, Paul R.	23	Rezin, Paul F.	54
Hinman, E. Harold	26	Rose, Harry M.	72
Hollaender, Alexander	43	Smith, Alice E.	73
Huff, Clay G.	21	Snyder, Thomas L.	41
Humes, Arthur G.	33	Stubbs, Trawick H.	22
Hunninen, A. V.	59	Stunkard, Horace W.	40
Hunter, George W., III	36, 79	Swanson, Leonard E.	83
Hunter, Wanda S.	36	Taliaferro, Lucy Graves	67
Hurlbut, H. S.	26	Taliaferro, W. H.	67
Hussey, Kathleen L.	4	Thomas, Lyell J.	39
Jacobs, Leon	43, 78	Threlkeld, W. L.	82
Jellison, William L.	30	Tidd, Wilbur M.	49
Jones, Myrna F.	43, 78	Van Cleave, Harley J.	7, 8
Kohls, Glen M.	31	Van den Berghe, Louis	42
Kotcher, Emil	36	Venard, Carl E.	46
Kouri, Pedro	87	von Brand, Theodor	48
Kudo, R. R.	29	Wall, Limas D.	64
Larsh, John E., Jr.	37	Wallace, Harold E.	61, 62
Lawler, Harry J.	71	Wenrich, D. H.	20
Leigh, W. Henry	6	Wilhelmi, Raymond W.	75
Leonard, A. Byron	73	Woodhead, Arthur E.	50
Levin, Arthur J.	53	Young, Martin D.	22

ABSTRACTS

1. *Two New Species of Unusual Strigeid Cercariae from the Douglas Lake Region, Michigan.* Louis Olivier, New York University.

About two thousand specimens of *Planorbula armigera* (Say) were examined during the summers of 1938 and 1939 and five were infected with a species of strigeid cercaria whose forebody is not especially noteworthy but whose tail is structurally and functionally peculiar. The forebody is characterized by the presence of four pairs of small penetration glands and two transverse commissures in the excretory system. The tail stem, unlike that of most other strigeids, is broad and is enlarged in the middle. It is thin-walled and contains a large cavity filled with a watery fluid. The tail stem is usually elongate with long, flat furcae. Under slight pressure it may be contracted to less than one-half its normal length and become broader than long with bulging sides and anterior and posterior indentations. At the same time the furcae contract until they are short and wrinkled. The second species was found in one specimen of *Valvata sincera* Say collected during the summer of 1939. This small cercaria has a short forebody bearing large suckers, a narrow tail stem of uniform diameter which is shorter than the forebody, and elongate, narrow furcae. The oral sucker has a ventral instead of a terminal opening and, in addition, it contains a structure suggesting the head gland of schistosome cercariae. There are two pairs of penetration glands anterior to the ventral sucker. The tail stem and furcae are usually elongate but under slight pressure the tail stem may be shortened considerably. However, in this case the cylindrical shape is maintained, the tail becoming uniformly broader. At this time the furcae become active and are then capable of great elongation and contraction.

2. *The Larval Stages of the Gull Strigeid,* Diplostomum flexicaudum, *in Juveniles and Adults of* Stagnicola emarginata angulata. W. W. Cort, Johns Hopkins University, D. B. McMullen, University of Oklahoma, Louis Olivier, New York University, and Sterling Brackett, University of Wisconsin.

S. emarginata angulata is an important intermediate host of *D. flexicaudum* in northern Michigan. The juveniles of this snail hatch in June and July and grow rapidly during the summer. They pass the winter under the ice and are all full grown by the next June. After the breeding season the adults begin to die naturally and their numbers are greatly reduced by the end of the second summr. None of the adults appear to live over a second winter. The juveniles begin to be infected with *D. flexicaudum* soon after they hatch. The earliest infections mature in late July and early August and may exhaust their cercariae by the end of the summer. Old infections almost entirely destroy the livers of the snails and appear to cause their death. Juveniles continue to be infected through the summer and large numbers of infections pass the winter in the snails. They are almost all either old or mature in the adult snails of the June collections and appear to run their course and disappear in the early summer. A new wave of infections mature in July and early August in the adult snails which appear to come from eggs dropped into the water in the spring. The oldest snails seem to have a greatly reduced susceptibility to infection. This yearly cycle of *D. flexicaudum* in its intermediate host indicates that miracidia penetrate the snails during most of the open season and that juveniles are as important as adults in its transmission.

3. *Experimental Studies on* Schistosomatium douthitti *(Cort) in Mouse, Rat, Muskrat, Guinea Pig, and Snow-shoe Hare.* Lawrence R. Penner, University of Michigan Biological Station and University of Minnesota.

Mouse, rat, muskrat, guinea pig, and snow-shoe hare readily become infected with cercariae of *Schistosomatium douthitti* (Cort). Experimental and natural infections indicate that young muskrats are the true natural definitive hosts, although *Microtus pennsylvanicus* may play the role of a natural host. In hosts studied,

albino rat is most refractory. In young muskrat, mouse, snow-shoe hare, and guinea pig, eggs of the fluke pass into the lumen of the intestine causing severe hemorrhage. Worms recovered in adult muskrats are small whereas they are of larger size in experimental and natural infections of young muskrats. Maximum length of adults is reached in snow-shoe hare and mouse. In albino mice worms reach the lungs by the third day after exposure to cercariae and are entering the liver on the fifth day. By the tenth day after exposure all the worms have reached the liver. By the time the worms reach the lungs the crura are filled with partly digested blood. They have a black appearance and make the worm easy to find. Union of the gut in the posterior part of the body is not apparent until after the worms have reached the liver.

4. *Development of the Excretory System in Digenetic Trematodes.* KATHLEEN L. HUSSEY, University of Michigan.

Development of the excretory system has been traced in cercariae belonging to nine families of trematodes. In early developmental stages the execretory system consists of a pair of primitive tubes extending to the postero-lateral body margin. The flame cell pattern results from growth of tubes and duplication of flame cells. The paired tubes fuse to form the primitive bladder, to which, in some families, may be added a heavy epithelial layer derived from a mesodermal cell mass. Forktailed cercariae, e.g. strigeids and schistosomes, form the bladder by fusion of tubes alone. Tubes discharge on the furci. Tubes are fused in tail stem except at "island of Cort" at anterior end. Amphistome and echinostome cercariae have a slight muscular development around the fused tubes in the bladder region. Fused tubes extend into the tail, with lateral openings which disappear coincidentally with the formation of a new pore at the place of contact of the fused tubes with the body surface. The bladder of cercariae of Opisthorchioidea forms as in echinostomes and amphistomes except for the addition of a thick epithelial layer of mesodermal origin. In stylet cercariae tubes never extend into the tail and the thick epithelial bladder derived from mesoderm is added to or replaces the primitive bladder. In all cercarial types studied the bladder forms first by fusion of tubes as in forktailed cercariae. This may be considered the fundamental plan of bladder formation. The epithelial layer and secondary pore are later evolutionary developments.

5. *A Review of the Trematode Superfamily Opisthorchioidea.* EMMETT W. PRICE, U. S. Bureau of Animal Industry.

A review of the flukes having pleurolophocercous and parapleurolophocercous cercariae shows that all belong to the superfamily Opisthorchioidea. An analysis of the characters of these cercariae fails to show sufficient correlation to be of much value in indicating family, subfamily, or generic relationships, these groups being separated on adult characters only. Within the Opisthorchioidea four families may be recognized largely on the shape and extent of the excretory bladder, this structure being Y-shaped with short crura extending to level of ovary in the Opisthorchiidae; more or less triangular in the Heterophyidae; short Y- or V-shaped with spacious crura extending to level of pharynx in the Cryptogonimidae; and Y-shaped with long stem and spacious crura extending to level of pharynx in the Acanthostomidae. Subfamily divisions are largely subjective and arbitrary. The following classification of the Opisthorchioidea is suggested:

Opisthorchiidae.—(1) Opisthorchiinae: *Opisthorchis, Clonorchis, Amphimerus, Cyclorchis, Cladocystis, Diasia, Pachytrema.* (2) Ratziinae: *Ratzia.* (3) Metorchiinae: *Metorchis, Parametorchis, Microtrema, Holometra.* (4) ?Phocitrematinae: *Phocitrema, Witenbergia.*

Heterophyidae.—(1) Heterophyinae: *Heterophyes, Heterophyopsis, ?Knipowitschiatrema.* (2) Metagoniminae: *Metagonimus, Metagonimoides, Acetodextra.* (3) Cryptocotylinae: *Cryptocotyle, Schaphanocephalus.* (4) Apophallinae: *Apophallus, Pricetrema, Euryhelmis, Tauridiana, Ponticotrema.* (5) Galactosominae: *Galactosomum, Stictodora, Acanthotrema.* (6) Centrocestinae: *Centrocestus, Pygi-*

diopsis. (7) Haplorchiinae: *Haplorchis.* (8) Stellantchasminae: *Stellantchasmus, Procerovum.* (9) Adleriellinae: *Adleriella.*

Cryptogonimidae.—(1) Cryptogoniminae: *Cryptogonimus, Caecincola, Centrovarium, Aphallus, Paracryptogonimus, Mehrailla, Exorchis, Pseudexorchis, Biovarium, Metadena.* (2) Neochasminae: *Neochasmus, Allacanthochasmus, ?Opisthometra.* (3) Siphoderinae: *Siphodera, Polyorchitrema, Siphoderina.*

Acanthostomidae.—(1) Acanthostominae: *Acanthostomum, Anoiktostoma.* (2) Oesophagicolinae: *Oesophagicola.* (3) Anisocoelinae: *Anisocoelium, Anisocladium.* (4) Isocoelinae: *Isocoelium, Paraisocoelium.*

6. *Variation in a New Cestode of the Genus* Raillietina (Skrjabinia) *from the Prairie Chicken.* W. Henry Leigh, Wright Junior College, Chicago, Ill.

Nine of fourteen young prairie chickens collected by the Illinois Natural History Survey from central Illinois harbored cestodes of the genus *Raillietina* (*Skrjabinia*) which are specifically different from other members of the genus. The collection, at first thought to comprise several species, showed several interesting variations to a degree not described for any of the other sixteen known species of the subgenus. Diagnostic characters showing the greatest range of variation were number and size of testes, and size and extent of cirrus pouch in complete gravid strobilae. Total length and breadth of entire gravid strobilae varied within wide extremes, but small size of strobilae seemed to be definitely correlated with a large number of individuals and large size with a small number of individuals. Scolex, egg capsule and onchosphere characters did not vary significantly. One interesting aspect of variation in this new species was the relative lack of variation in the strobilae of any one host. Characters within any one strobila and within all the complete gravid strobilae of one host were quite uniform but in several respects differed noticeably from host to host, though the latter were all taken from the same area. This would seem to indicate a considerable degree of flexibility of some morphological characters to environmental factors as determined by the host. Absence of cestodes in all adult prairie chickens collected suggests that only young birds are susceptible to this helminth. Since the species differs from all known poultry cestodes, it seems reasonable to think it might be indigenous to the prairie chicken.

7. *Systems for Designating Hook Pattern in Acanthocephala.* Harley J. Van Cleave, University of Illinois.

Quincunxial order is the most common arrangement of hooks on the proboscis of Acanthocephala. In this pattern, longitudinal, cross, and diagonal rows are evident. While diagonal rows offer a convenient method of counting the longitudinal rows, formulae are usually expressed in terms of number of longitudinal rows with the number of hooks in each. On some proboscides, the hooks do not fall in straight lines and in some the hooks at the base of the proboscis are not in quincunxial order. For these Meyer (1931) has introduced a system of spirals and bifurcating spirals. His formulae are based largely on polar projection of hook pattern, having a tendency toward subjective error in reconstruction. In his projections of spiral pattern, the hooks fall as clearly into perfect circles as into spirals. His bifurcating spirals arise from crowding of the hooks at the base of the proboscis so that two adjacent circles fuse. In these the formula is readily expressed in the conventional terms of longitudinal rows with the hooks at the base of the proboscis lacking the quincunxial order for in the fused circles the hooks fall in the same longitudinal rows. This is a portion of a more extensive study attempting to analyze all types of variation and asymmetry in the pattern of hook arrangement on the proboscis of the Acanthocephala.

8. *A Reconsideration of the Acanthocephalan Family Rhadinorhynchidae.* Harley J. Van Cleave, University of Illinois, and David R. Lincicome, Tulane University.

Among the diverse species now included in the expanded concept of the family Rhadinorhynchidae Travassos, 1923 (Acanthocephala: Palaeacanthocephala), the form of the proboscis and the number of cement glands of the male, now fall short as unifying characters on which to base the family. An analysis of all the available characters has demonstrated that the number of cement glands of the male, supported in part by associated changes in form of the proboscis, provides a basis for aligning the genera of the Rhadinorhynchidae into two natural groups: 1) Those genera possessing eight cement glands. 2) Those genera possessing four cement glands. It is proposed to recognize a new family, the Gorgorhynchidae, for those genera possessing four cement glands, with *Gorgorhynchus* Chandler, 1934, as genotype and including *Aspersentis* Van Cleave, 1929, *Cleaveius* Subramanian, 1929, *Filisoma* Van Cleave, 1928, *Micracanthocephalus* Harada, 1938, *Nipporhynchus* Chandler, 1934, and *Serrasentis* Van Cleave, 1923. The number of cement glands in *Filisoma* is established, and the genus is assigned to the Gorgorhynchidae. *Nipporhynchus katsuwonis* (Harada, 1928) is established as a direct synonym of *Rhadinorhynchus ornatus* Van Cleave, 1918 (unpublished data) which becomes the type of *Nipporhynchus*. *Rhadinorhynchus trachuri* Harada, 1935 and *Rhadinorhynchus nudus* Harada, 1938 are referred to *Nipporhynchus* and a re-definition of the genus is given. It is further proposed to restrict the family Rhadinorhynchidae to those genera bearing eight cement glands: *Illiosentis* Van Cleave and Lincicome, in press, *Leptorhynchoides* Kostylew, 1924, *Polyacanthorhynchus* Travassos, 1926, *Tegorhynchus* Van Cleave, 1920, *Rhadinorhynchus* Lühe, 1911, and *Telosentis* Van Cleave, 1923.

9. *Notes on the Leeches (Piscicolidae) Living on Fresh-Water Fishes of North America.* Marvin C. Meyer, University of Kentucky.

A morphological and taxonomic study was made of fresh-water fish leeches of North America. The twenty-six generally recognized genera of the family have been analyzed. Only eight of the genera have been reported from North America and only two of these (*Piscicola* Blainville, 1818 and *Cystobranchus* Diesing, 1859) from fresh-water fishes. Within the genus *Piscicola* there have been previously included species with a variable number of paired testes and of annuli to a complete somite. Detailed studies of total mounts and serial sections of individuals showing these variations revealed correlated differences in other anatomical features. Four new species possessing five pairs of testes have been separated from the genus *Piscicola* and placed in a newly recognized genus *Illinobdella,* and one new species with five pairs of testes have been assigned to *Piscicolaria* Whitman, 1887, emended. One new species has been described which belongs to the genus *Cystobranchus*. Generic and specific differences will be discussed.

10. *Geographical Distribution of North American Branchiobdellids.* Clarence J. Goodnight, University of Illinois.

The Branchiobdellidae are a group of Oligochaetes known only from the exoskeleton and gills of fresh-water crayfishes. The writer undertook a study of the group which incidentally resulted in defining the ranges of the various species known from North America. In this study four new species have been found, one species has been reduced to subspecies rank, and one new genus has been recognized. This study indicated that North America may be divided into distinct faunal regions for this family. So far as is known these regions appear to be (1) an Eastern, (2) a Great Basin, (3) a Northwestern, and (4) a North Californian. The Eastern region includes the following species: *Branchiobdella americana, Cambarincola macrodonta, Cambarincola vitrea, Cambarincola elevata* n. sp., *Cambarincola chirocephala, Cambarincola philadelphica, Xironogiton instabilius instabilius, Xironodrilus formosus, Xironodrilus pulcherrimus, Bdellodrilus illuminatus, Pterodrilus alicornus, Pterodrilus distichus, Pterodrilus durbini,* and *Pterodrilus mexicanus*. The Great Basin contains *Cirrodrilus thysanosomus*. The Northwestern includes *Cambarincola inversa, Xironogiton instabilius oregonensis, Triannulata magna* n. gen.,

n. sp., and *Triannulata montana* n. sp. The North Californian includes *Branchiobdella tetradonta* and *Stephanodrilus obscurus* n. sp. Undoubtedly further investigation will demonstrate additional regions.

11. *A Cercarial Survey of the Lake Okoboji Region of Iowa.* E. L. Miller, Louisiana State University.

Descriptions of the cercariae of a region and the ability to recognize them constitute major steps toward the determination of many trematode life histories of the area. Due to an increasing number of known life histories one can determine many of the adults present by a comprehensive survey of the cercariae. Twenty-six species of cercariae and eight species of metacercariae were found by making 1,152 identifications of larval trematode infections. Of these infections, 322 were cercarial and 830 were metacercarial. Only one case of dual cercarial infection in a single gastropod was noted. Host-specificity relationship is not a very limited one for cercariae. Each of three of these cercarial species parasitizes three gastropod genera, and each of seven others parasitizes two host genera. However, a decided preference is shown by most cercaria for a particular snail host species. Of the gastropods collected over a three-year period, 9.3% were infected with cercariae and 18.0% with both cercariae and metacercariae. This percentage may be correlated with such factors as the presence and abundance of migrant and intermediate hosts, the time of year when collections are made, amount of rainfall, and size of bodies of water where collections are made. It is logical to assume that many of these cercariae do not complete their life cycles in the place where they are collected. This may apply equally to the adult trematodes of the region. The migratory water birds of the Okoboji region are especially responsible for this situation.

12. *Studies on Monogenetic Trematodes. III. Redescriptions and Variations in a Few Known Species.* John D. Mizelle, Oklahoma Agricultural and Mechanical College.

Material collected from Tennessee by Dr. R. V. Bangham of Wooster College, Wooster, Ohio, has rendered possible the redescriptions of *Actinocleidus fusiformis, A. bursatus, Cleidodiscus banghami,* and *Urocleidus furcatus.* These have been made for each species on the basis of ten or thirteen specimens taken from two or more hosts. New geographical and host records, or new geographical records only, have been made for the foregoing and other species, namely, *Cleidodiscus bedardi, Actinocleidus articularis,* and *Urocleidus principalis.* Comparisons of body dimensions and critical internal structures have been made for each species with reference to hosts and localities. These are presented by descriptions and/or tables of measurements. In most cases, parasites from localities in Illinois possess greater body size but do not always have larger internal structures than do specimens from Tennessee. Minima and maxima for parasites of a given species (from Tenn.) are rather uniformily distributed among specimens from the available hosts.

13. *The Life Cycle of* Cornucopula nassicola *(Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae).* John S. Rankin, Jr., Amherst College.

Metacercariae found encysted in the pericardial sinus of the sand flea, *Talorchestia longicornis,* were fed to three young herring gulls. Adults of *Cornucopula sippiwissettensis* were recovered five days later. Two control birds were negative. Cercariae from the mud snail, *Nassa obsoleta,* identified as *Cercaria nassicola,* were found to develop into metacercariae of this worm when placed with *Talorchestia.* Only one ventral sucker is visible in very young metacercariae, but both ventral suckers, as well as the whole genital complex, are well developed in older cysts.

14. *Life Cycle Studies on* Spinitectus gracilis *and* Rhabdochona *sp. (Nematoda: Thelaziidae).* Paul V. Gustafson, Whitworth College, Spokane, Wash.

Mayfly larvae of the genera *Hexagenea, Heptagenea,* and *Streptonoura* readily ingest embryonated eggs of *Spinitectus gracilis.* Numerous motile toothed first-stage larvae are present in the intestine of the host twelve hours after exposure. Advanced larval stages are found in the body cavity after three days; specific characteristics appear within eight days. Young adults were recovered from green sunfish three days after infection with eleven-day old larvae. *Hexagenea* larvae were also infected with the eggs of *Rhabdochona* sp. from *Aplodinotus grunniens* taken from Lake Decatur, Illinois. Larval stages and migrations are very similar to those of *Spinitectus gracilis.* Young adults were recovered from *Ameiurus melas three* days after infection with twenty-day old larvae.

15. *Observations on the Life Cycle of* Nudacotyle novicia *Barker, 1916 (Trematoda: Notocotylidae).* Donald J. Ameel, Kansas State College.

Lettuce, bearing cysts of *Cercaria marilli* Ameel, 1939, from *Pomatiopsis lapidaria* collected at Marion, Iowa, and Ann Arbor, Michigan, was fed to a meadow mouse, *Microtus pennsylvanicus.* Trematodes identified as *Nudacotyle novicia* were found in a greatly enlarged bile duct after three weeks. This is a common species inhabiting the small intestine of the muskrat. Specimens from the muskrat average 0.661 by 0.376 mm and are cup-shaped with truncate posterior ends. Specimens from the meadow mouse average 1.02 by 0.532 mm and are relatively flat with tapered posterior ends. Two of six meadow mice collected at Marion yielded specimens of *Nudacotyle novicia* from the bile duct. The possibility that two species are involved is being considered. However, no significant basis for such differentiation has been recognized as yet.

16. *Development of Trematode Metacercariae into Adult Worms in Sterile Cultures.* M. S. Ferguson, Rockefeller Institute for Medical Research, Princeton, New Jersey.

Metacercariae of the strigeid *Posthodiplostomum minimum,* were recovered from the livers and kidneys of sunfish and excysted in acidified pepsin solution. They were then freed from bacteria by a series of washings in tubes of sterile isotonic saline solution. Sterile excysted metacercariae remained alive and infective for young previously unfed chicks for at least one month when stored in this saline solution at refrigerator temperatures (5–7° C). These larval worms after inoculation into tubes of special sterile liquid media lived and developed toward the adult condition when incubated at a temperature of 39° C. In cultures, as in birds, when the metacercariae matured into adult worms there was no increase in body size. Growth and differentiation of the reproductive organs was noted in worms from cultures, and secondary sexual changes which normally appeared during development of the metacercariae into adult worms were also observed. Spermatozoa, normal in appearance, were produced in great numbers by the enlarged testes and completely filled the seminal vesicle. Vitelline material was produced and transferred into the vitelline reservoir. Eggs were observed in the uteri of a small number of worms from cultures and some were discharged from the genital pore. The eggs found free in the media were usually normal in size, but only a few were typical in shape, and all had very thin amber shells. It has not yet been determined whether the spermatozoa and eggs were physiologically normal.

17. *A New Cultivation Medium and Its Use in the Cultivation of* Nyctotherus cordiformis. E. Clifford Nelson, University of Maine.

Alcohol preserved tissues have been found to serve as a satisfactory base for a medium for the cultivation of *Nyctotherus cordiformis* from the frog. The organism has been kept in continuous cultivation for over seven months. Individual tubes last for as long as six months.

18. *The Cultivation of* Endamoeba histolytica *without Serum.* Lucy V. Reardon and Charles W. Rees, National Institute of Health.

Locke's solution without the addition of serum, or of any other supplement, has been used successfully as an overlay for egg slants in the cultivation of *Endamoeba histolytica*. This modified Boeck-Drbohlav medium with rice flour has supported abundant growth of four strains of *E. histolytica*, one of which has been in continuous cultivation for seven months and three for four months. All of these strains have encysted in this medium and one strain has supplied cysts for the initiation of a number of cultures, which, to date, have been maintained from one to several months. Without rice flour in the medium, good, but not flourishing, growth has proceeded over a period of two months. According to present indications, this modification of Boeck-Drbohlav's medium will support the growth of *Endamoeba histolytica* indefinitely.

19. *The Microisolation of* Endamoeba histolytica *and Its Cultivation with Single Species of Bacteria.* CHARLES W. REES, National Institute of Health.

A micromanipulator has been constructed and used successfully in the isolation of *Endamoeba histolytica*. Large numbers of cysts were produced in Erlenmeyer flasks by the method of Frye and Meleney, were washed free from trophozoites and harvested by flotation on zinc sulphate solution. Cysts were isolated from bacteria with the micropipette and were transferred to Boeck and Drbohlav's medium; previously the air and other gases had been removed in a vacuum chamber from the medium and the latter overlaid with sterile paraffin oil. After cultivation for 24 hours at 37.5° C, each tube that appeared to be sterile was seeded with a known species of bacteria. Cultivation of up to 300 cysts that had been harvested a week or more previous to isolation and maintained at 10° C was unsuccessful; cultivation of several thousand cysts was successful. In approximately one-third of the isolation of 100 to 300 freshly harvested cysts, cultures of *E. histolytica* were successfully obtained; the positive cultures were recognizable after from 4 to 7 days of incubation.

20. *Some Unusual Variations in Cystic Stages of Intestinal Amoebae.* D. H. WENRICH, University of Pennsylvania.

Experienced students of the intestinal protozoa of man are familiar with the fact that it is sometimes difficult to distinguish between *Endamoeba histolytica* and *E. coli* in the trophic stages, while the cystic stages are usually readily differentiated. Occasionally, however, amoebic strains are found which show more than the usual range of variation in the cysts, so that characters of size, number and structure of nuclei and chromatoid bodies appear to overlap those of closely related species. For example, in a set of slides showing cysts of a large race of *E. histolytica*, there were many evidences of biological instability including a range of size from 12 to 20 microns, nuclear numbers from 1 to 8 (most had 4 nuclei), a high percentage (about 40%) with "buds," a high percentage (about 50%) with nuclei of the "Councilmania" type, irregularities of size in the nuclei of single cysts, with over-sized nuclei possibly parasitized, various types of nuclear degeneration, and some cysts with *Sphaerita* or other kind of cytoplasmic inclusion; most had *E. histolytica* type of chromatoids, if any, but some had filamentous chromatoids, like those sometimes found in *E. coli*, or both types together. Other sets of slides show other conditions of unstable or intermediate characters.

21. *Quantitative Studies on Avian Malarial Oöcysts.* CLAY G. HUFF, University of Chicago.

Measurements were made of oöcysts grown in *Culex pipiens* at constant temperatures and for definite periods of time. From these, the average volumes were calculated for each age and temperature. A strain of *Plasmodium relictum* (*V*) and three strains of *P. cathemerium* were studied in this fashion. Of the latter, one was a single-cell strain (*N*), another a strain derived from *N* by mosquito passage (*U*), and a third was a strain from a magpie, very pathogenic for canaries (*M*). No effects could be detected of mosquito passage on the single-cell strain.

Oöcyst sizes of *P. cathemerium* were significantly higher than those of *P. relictum*. Although data for the curves covering the early portion of the period of growth could not be obtained, it would appear that the growth curves are logistic. Evidence was found for individual differences in mosquitoes in regard to the rate of growth of oöcysts infecting them.

22. *Studies on Induced Quartan Malaria in Negro Paretics. II. The Effect of Reversal of the External Conditions upon the Infection.* Martin D. Young, G. Robert Coatney, and Trawick H. Stubbs, U. S. Public Health Service, Columbia, S. C.

This strain of malaria has a high synchronicity and a marked periodicity, as recently shown by the authors. After establishing the periodic phenomena, the patients were then put on a schedule of sleeping in a dark room during the day and working and eating under artificial light at night. The time of the sporulations began to change within several days, and after a week or so were almost completely reversed. When the patients were again placed on a normal schedule, the sporulations tended to revert to normal.

23. *The Development of* Dipetalonema diacantha *and* Dirofilaria spinosa *in Mosquitoes.* Paul R. Highby, University of Minnesota.

The filarial worm, *Dipetalonema diacantha* (Molin, 1858), was found in eighteen out of twenty-five porcupines, *Erethizon dorsatum* (L.). The microfilariae were taken into the mid-gut of the mosquito with its blood meal. The larvae migrated into the body cavity through the Malpighian tubules, emerging from the tubule tail-first. They developed through the first and second larval stages in the fat body and thorax of the mosquito. The active third larval stage migrated throughout the body and into the labium. From the labium they emerged into a drop of porcupine serum without the stimulus of heat, pressure, or weight of cover-slip. The point of emergence from the labium depends upon the species of mosquito. Mosquitoes in which development proceeded into the third larval stage are *Aedes canadensis, A. cinereus, A. fitchii, A. stimulans, A. vexans, A. aegypti,* and *Taeniorhynchus perturbans.* Porcupines were also found to harbor *Dirofilaria spinosa* Canavan, 1929. Some were infected with both *D. spinosa* and *Dipetalonema diacantha,* others had either of the species alone. The species may be diagnosed by distinctive characters of the microfilariae obtained from the blood. In *Mf. diacantha* the cephalic space is longer than the embryo's diameter, whereas in *Mf. spinosa* it is shorter. The larva of *Dirofilaria spinosa* completed its development in *Aedes stimulans.*

24. *Ticks* (Ornithodoros *spp.*) *in Arizona Bat "Caves."* Cornelius B. Philip, U. S. Public Health Service, Hamilton, Montana.

Two species of "soft" ticks were taken in association with bats in certain mine tunnels in southern Arizona. The bat-guano tick, *Ornithodoros coprophilus* McIntosh, was observed and collected for the first time under natural habitat conditions. Thousands were found crawling on the surface of guano on the floor of a 310-foot tunnel in Picacho Mountain. Only the innermost 50 feet were infested although the guano was distributed continuously throughout the length of the tunnel. An estimated surface square foot yielded 301 ticks of all stages from early nymphs to adults, as well as molted skins. Although hundreds of bats were dislodged from their day-time roosts on the seven-foot ceiling, no *coprophilus* were found parasitizing the bats, nor on the rocky ceiling or side walls above the guano, nor were any found showing evidence of blood-meals. None offered to feed on the person of the observer and thus far all have refused to attack laboratory animals. The habits and developmental requirements of this tick remain speculative and may differ radically from those of other known species. A small number of engorging larval *Ornithodoros* were found on a few bats, part from this cave and part from two others, one in the Santa Rita Mountains and one near Arivaca. The infested bat species were *Antrozous pallidus pallidus* (Lec.) and *Myotis velifer velifer* (Allen). Some larvae

have since molted twice, without feeding, to *talaje*-like nymphs. These are definitely not immature *coprophilus* and no larvae of the latter have been discovered or reared to date.

25. Hypoderma *Myiasis in the Horse—Summary of a Series of Cases Studied During Spring and Summer, 1939.* D. W. Baker and W. S. Monlux, New York State Veterinary College.

In the course of the past five years a considerable number of inquiries have been received by us from practising veterinarians in northeastern United States regarding the nature and cause of subcutaneous myiasis in horses. The incidence of cases is apparently increasing and there is a paucity of published data on the epidemiological and pathological aspects of the parasitism. In one group of 79 riding horses, 21 showed positive evidence of grub infection with the lesions appearing in the middle of the back, which incapacitated them for work. Larvae were squeezed from the lesions in several cases. In another case of a horse suffering from a nervous disturbance of uncertain etiology, the larva was found on postmortem to have migrated to the brain. Data concerning the seasonal incidence, possible sources of infection, pathogenicity and pathology of the parasitisms are presented. The information is illustrated with pictures of parasitized horses, showing lesions and the emerging larvae, actual specimens of the larvae removed from the skin and the brain, and tissue preparations to show the pathology of the brain injury.

26. *A Study of Winter Activities and Hibernation of* Anopheles quadrimaculatus *in the Tennessee Valley.* E. Harold Hinman and H. S. Hurlbut, Tennessee Valley Authority, Wilson Dam, Alabama.

These studies indicate that *Anopheles quadrimaculatus* probably passes the winter in the Tennessee Valley chiefly as inseminated adult females. No evidence of the survival of the immature stages has been discovered. A fat reserve is accumulated in the autumn which gradually diminishes during the winter. The number of individuals in hibernating places (caves, etc.) reaches its maximum during the latter part of November. Hibernating females in caves have survived as long as 69 days without food. The temperature ranged from 51.5° to 59° F between December 16 and January 27 in one cave where continuous record was kept. A renewal of reproductive activity occurs early in February and the overwintering females leave the caves at this time. Autumn reared specimens survived the winter (133 days) in a small outdoor cage. During November and December ovarian development appears to be deterred at temperatures below 59° F and stimulated at temperatures of 68° F and above. Intermediate temperatures have not been explored. Under artificial conditions during October, no evidence of gonotrophic dissociation was observed. Oöcysts were discovered on the stomach of one specimen found in a cave on December 1.

27. *How Rocky Mountain Spotted Fever Vaccine Is Prepared And Used.* Cornelius B. Philip, U. S. Public Health Service, Hamilton, Mont.

Motion Picture.

28. *Segmentation in the Internal Organs in Infections with a Mexican Strain of* Plasmodium relictum. Redginal Hewitt, Johns Hopkins University.

In infections with a strain of *Plasmodium relictum* isolated from a common house finch in Mexico and inoculated into canaries the parasites were not equally distributed throughout all parts of the body at different periods during the asexual cycle. A short time previous to maximum segmentation many more segmenters occurred in the liver than in the peripheral blood, bone marrow or spleen. Directly after segmentation most of the ring stages found were in the peripheral blood. Throughout the patent period many variations occurred in the localization of certain stages of the parasite in different parts of the body. In some birds many more parasites occurred in the bone marrow than could be found in the peripheral blood

or liver, while in others the number of parasites in the bone marrow was exceedingly low as compared with the liver and spleen at the same time. The general trend, however, showed many more parasites in the liver than in any other parts of the body examined, particularly segmenters. The factors governing this shifting of different stages of the parasite from one part of the host to another are not understood. The same phenomenon is of course well known in *P. falciparum* infections in man and in infections with *P. elongatum* in birds. Several other genera of blood protozoa in birds (e.g. *Haemoproteus, Leucocytozoon, Trypanosoma*) likewise exhibit the same type of unequal distribution in the body with regard to certain stages in their life cycles. Further work with the strain of *P. relictum* mentioned above is now in progress.

29. *On the Development of* Nosema bombycis *in the Fall Webworm,* Hyphantria cunea. R. R. Kudo and J. D. De Coursey, University of Illinois.

Larvae of the fall webworm, *Hyphantria cunea*, were allowed to feed for thirty minutes on mulberry leaves on which spore-emulsion of *Nosema bombycis* taken from infected silkworms, was smeared, and, thereafter, on normal unsmeared leaves until they pupated. Daily microscopical examinations revealed that the spores of the microsporidian germinate in, or pass out of, the intestine of the webworm larvae during 24 hours following their introduction per os. The spores did not reappear in the feces until the eleventh to fourteenth days after the beginning of the experiment. All pupae developed from the infected larvae were enclosed in a very thin cocoon, except one which was entirely naked, while the control pupae were fully enveloped in silken cocoons, save on the sides that were in direct contact with the walls of the glass container. One infected larva which was unable to pupate, lived for 10 days after others pupated, and finally died. This larva showed the same well-known symptoms of the silkworm heavily infected by this microsporidian. As in the case of the silkworm, all tissues of the webworm larvae were subject to infection. Examination of various developmental stages of the microsporidian shows that its development in the larva of *Hyphantria cunea* is essentially the same with that in *Bombyx mori* (Kudo, 1916).

30. *The Burrowing Owl as a Host to the Argasid Tick,* Ornithodoros parkeri. Wm. L. Jellison, U. S. Public Health Service, Hamilton, Montana.

The presence of mammalian fleas in the burrows and nests of the western burrowing owl, *Speotyto cunicularia*, has been reported by the writer. (1938, J. Parasitol. **12** (Dec. Suppl.): 12; also 1939, Pub. Health Rep. **54**: 792–798.) Examination of 18 burrows of this owl in Washington State during June, 1939, yielded additional mammalian fleas and large numbers of the argasid tick, *Ornithodoros parkeri* Cooley. *O. parkeri* and other *Ornithodoros* ticks are usually parasites of mammals and rarely reported from birds. Many of the specimens collected were freshly engorged with avian blood. Nine nests, in Franklin, Douglas, Yakima and Okanogan Counties, were found infested with a total of 1318 ticks. The maximum infestation in one burrow was 491 ticks. This owl appears to be accepted as a host by *O. parkeri*. It is suggested that the burrowing owl may be found harboring other species of *Ornithodoros* in other parts of its range which extends from southern South America northward well into Canada.

31. *Siphonaptera: A Study of the Species Infesting Wild Hares and Rabbits of North America North of Mexico.* Glen M. Kohls, U. S. Public Health Service, Hamilton, Montana.

Available data are presented pertaining to the distribution and host relationships of the nine species and subspecies of fleas infesting wild hares and rabbits of North America north of Mexico. These species are: *Cediopsylla simplex* (Baker) 1895, *C. inaequalis inaequalis* (Baker) 1895, *C. inaequalis interrupta* Jordan 1925, *Hoplopsyllus glacialis glacialis* (Tasch.) 1880, *H. glacialis lynx* (Baker) 1904, *H. affinis* (Baker) 1904, *H. foxi* Ewing 1924, *Odontopsyllus multispinosus* (Baker)

1898 and *O. dentatus* (Baker) 1904. All known collection records are listed, maps are presented showing localities where the several species have been collected and the distributional range of each species as now known is discussed. A key and illustrations are given to aid in identifying the species. The occurrence of *Echidnophaga gallinacea* (West.) on wild hares and rabbits is reported and new states and counties are listed where *Pulex irritans* L. has been collected from these hosts. A brief section giving pertinent information relating to the wild hares and rabbits of the region concerned precedes the flea data. Part of the work was done in the Division of Entomology and Economic Zoology, University of Minnesota, St. Paul.

32. *The Life Cycle of* Monorcheides Cumingiae (*Martin*) (Trematoda: Monorchidae). W. E. Martin, DePauw University.

The life cycle of *Monorcheides cumingiae* involves the development of sporocysts, cercariae and metacercariae in the marine bivalve, *Cumingia tellinoides* (Conrad) and the maturation of the worm under experimental conditions in the anterior part of the intestine of eels and flounders. The anatomy of the various stages in the life cycle is described and consideration is given to the effect of the parasite on the various organs of the clam. The cercaria bears eyespots, has an excretory formula of $2[(2+2)+(2+2)]$, and has a tail provided with lateral lappets. In the adult worm the terminal portions of both genital tracts are armed with heavy triangular spines.

33. *The Life History of* Stichorchis subtriquetrus (*Trematoda: Paramphistomidae*). Harry J. Bennett and Arthur G. Humes, Louisiana State University.

Several beavers, *Castor canadensis carolinensis,* trapped near Baton Rouge, Louisiana in February and March of 1939 were found to be infected with *Stichorchis subtriquetrus.* The eggs of this trematode develop in about three weeks. The miracidium contains one well-formed redia which is liberated within the snail host, *Fossaris parva,* about 48 hours after penetration. Daughter rediae containing four or five germ balls are present in the snail within 21 days. This generation of rediae produces cercariae which are found free in the tissues of the snail about 35 days after infection. The cercariae are fully-formed when freed from the rediae but are somewhat smaller than the mature ones. The latter escape from the snail approximately fifty days after infection. They are not large when compared with other amphistome cercariae but like most of them are heavily pigmented. Encystment occurs within an hour and the metacercariae are infective immediately. Specimens encysted on lettuce were fed to guinea pigs and mature forms were recovered four and a half months later.

34. *Life History Studies on Monostomes of the Genus* Notocotylus (*Trematoda*). E. C. Herber, Dickinson College.

The cercaria of *Notocotylus quinqueserialis* Barker and Laughlin, 1911, was found in *Gyralus* sp. collected from several localities on Douglas Lake, Michigan. This is a small trioculate cercaria whose body and tail are both capable of considerable extension and contraction. Soon after the cercariae emerge they encyst. Metacercariae when fed to *Microtus pennsylvanicus pennsylvanicus* developed to maturity in the cecum in 15 days. The muskrat has previously been reported as a field host. Redia-producing rediae were found in field infections. A second trioculate cercaria, found frequently in several species of *Physa* and in *Stagnicola emarginata angulata* in and around Douglas Lake, Michigan, was identified as *Cercaria urbanensis* Cort, 1914. Cysts, obtained from these cercariae, fed to a young muskrat yielded mature worms on the 10th day. One heavily infected snail fed to a young rooster also produced adult worms. These worms were identified as *Notocotylus urbanensis* (Cort, 1914) Harrah, 1922. Harrah gave the name *urbanensis* to his *Notocotylus* because he considered from morphological comparisons that it was the adult of *C. urbanensis.* A third trioculate cercaria was found in one snail of *Stagnicola emarginata canadensis* taken from a lake rather distant from Douglas Lake. This

cercaria, generally smaller and less pigmented, emerged later in the day and encysted more slowly than *C. urbanensis*. Moreover, the excretory tubules entered the excretory vesicle at the anterior end and did not encircle the median eyespot. Metacercariae, encysted on lettuce, when fed to chickens, domestic and merganser ducklings were infective at once. Maturity is completed in about 10 days. The testes of these adult worms were longer and more deeply lobed than those of *N. urbanensis*.

35. *The Life Cycle of* Euparyphium melis (*Trematoda: Echinostomidae*). Paul C. Beaver, Lawrence College.

The cercaria of *Euparyphium melis* (Schrank) was found in *Stagnicola emarginata angulata* (Sowerby) from Douglas Lake, Michigan. Its redia is of the long-gut type with very prominent appendages and four-lobed collar. Free-swimming cercariae enter the cloaca of several species of tadpoles and encyst in the adjacent tissues at the base of the tail. Metacercariae of diverse ages failed to develop into adult worms when fed to cats, rats, mice, and pigeons, but were found nearly mature in the duodenum of a ferret after 11 days. In the case of the ferret, the metacercariae were 26 to 37 days of age and were in tadpoles of *Rana clamitans*. Field infections of *E. melis* occur in the mink (*Mustela vison*) in North America.

36. *Studies on Clinostomum. VI. The Penetration and Post-cercarial Development of* Clinostomum marginatum (*Rud.*). George W. Hunter, III and Wanda S. Hunter, Wesleyan University, and Emil Kotcher, Johns Hopkins University.

The penetration of the guppy, *Lebistes reticulatus*, by the cercaria of *Clinostomum marginatum* is described and the subsequent post-cercarial development traced. Observations were made immediately upon penetration, and thereafter at 18 hours, followed by observations in 1, 2, 3, 5, 7 and 10 weeks. Penetration was followed by mild leucocytosis. Within three weeks strands of host connective tissue were visible about the parasite. The cyst was completely formed in six to seven weeks. The post-cercarial development is characterized by a "reorganization stage" as was noted in some of the related Strigeidae. The degeneration of cercarial structures is apparent and is followed by the gradual development of metacercarial and adult structures. Many of these structures seem to have their origin in a mass of cells occurring as a genital primordium in the cercaria.

37. *Life Cycle of* Corallobothrium *sp. from* Ameiurus nebulosus. John E. Larsh, Jr., University of Illinois.

Mature tapeworms were secured from small bullheads taken at Black Lake, Michigan. The mature worms were placed in tap water to expel the eggs. These eggs, measuring from 18 to 21 microns in diameter, were found to be infective. Various species of *Cyclops* and *Diaptomus* taken from Douglas Lake were placed in a petri dish with hundreds of the infective eggs. Examination twice daily showed no apparent results until the eighth day when the body cavity of several *Cyclops prasinus* was found to be packed with procercoids (twelve in one case). The average size of the procercoids at this stage was 342 microns long by 112 microns wide. To determine whether or not these procercoids would go into another intermediate host a few small tropical fish, *Glaridichthys talcatus*, were fed infected *Cyclops*. After two days the fish were found to harbor plerocercoid cysts both in the intestinal mucosa and in the body cavity. Apparently no change had occurred in the larval forms in the fish. However, at this time it cannot be stated whether fish are true intermediate hosts or merely auxiliary hosts. To determine this would necessitate closer examination of the fish at various intermittent periods. Lack of material made this impossible. For the present, we must consider a second intermediate host as a necessary phase of the cycle. The plerocercoid cysts measured approximately 158 microns long by 189 microns wide. The infected tropical fish were fed to half-starved bullheads which were known to be parasite-free. In four days the plerocercoids were recovered from the small

intestine. Thus, the entire life cycle was carried out in about fifteen days. From infective eggs to fully developed procercoids in the *Cyclops* about eight days; transfer of procercoid into second intermediate host about three days; transfer of plerocercoid from second intermediate host into definitive host about four days.

38. *Preliminary Investigations on the Life Cycle of a Cestode of the Mouse,* Mus musculus. R. C. RENDTORFF, University of Illinois.

The author has completed the life cycle of a tapeworm closely resembling the Anoplocephalan genus *Oochoristica.* The tapeworm occurs in the house mouse, *Mus musculus.* The infection cannot be transmitted directly but requires an intermediate host which may be one of the following stored-grain insects: adults of the confused flour beetle, *Tribolium confusum,* or the rust-red flour beetle, *T. castanèum.* Larvae of these species have not been studied. The dermestid, *Trogoderma* sp., may serve as an intermediate in both the larval and adult stage and the cysticercoids within the larva remain infective throughout the insect's transformation to the adult. The larvae of the dark and yellow meal worms, *Tenebrio obscurus* and *T. molitor,* are unable to serve as intermediates. Adults of these species have not been studied. The Oriental cockroach, *Blatta orientalis,* is also apparently unable to serve as an intermediate host. Other household and stored-grain insects as well as orbatid mites are being investigated. Insects acquire the infection by eating gravid proglottids voided in the feces of the mouse. The eggs hatch within the gut of the insect and the hexacanth embryos penetrate into the haemocoele where they undergo rapid growth for a period of 11 to 13 days when scolex formation occurs. In about 2 to 3 weeks the cysticercoids, floating free in the body fluids, have completed development and are infectious to the mouse. The tapeworm matures in the mouse in about 3 weeks after ingestion.

39. *Further Studies on the Life Cycle of a Cestode from the Herring Gull.* LYELL J. THOMAS, University of Illinois.

Young herring gulls and a Caspian tern, hatched in an incubator, were experimentally infected with a new species of *Diphyllobothrium* by feeding them plerocercoids from stomach cysts in herring taken in Lake Michigan. Cats fed cysts from the same source developed tapeworms similar to those from the birds as well as an unknown *Diphyllobothrium.* The unknown worms may be *D. laruei* Vergeer, 1934 although Skinker (1935) does not consider this to be a valid species. Only young gulls were found harboring the new *Diphyllobothrium* in a natural infection. As the weights of the young gulls increased and feathering took place the mature worms were shed. Cloacal temperatures of very young gulls ranged from 99.8° F to 103° F. Their body weights were 61 grams to 121 grams. A young gull weighing 595 grams and almost fully feathered lost its worm when the body temperature reached 105° F, even though on an adequate diet. In nature, mature worms have not been found to date in gulls two years old or more. Wetmore (1921) gives the mean body temperature of adult herring gulls as 108.2° F. One dozen day-old chicks were placed on a fish diet and given one plerocercoid each but did not take the infection. The mean cloacal temperature of five of these birds picked at random from chicks outside the brooder averaged 105° F. This initial high temperature in chicks may be a factor in preventing their infection. This same factor may also help to explain the rapid shedding of ligules by fish-eating birds. Plerocercoids from herring placed under the skin of a frog, a snake, a chick, and a rat did not develop. Plerocercoids developed in guppies by feeding them experimentally infected *Diaptomus.* Natural infections were taken in minnows, *Notropis deliciosus,* from Douglas Lake, Michigan. From the known facts the writer is of the opinion that he is dealing with a tapeworm which may adapt itself to many hosts if within certain ranges of body temperature.

40. *Life History Studies and the Development of Parasitology.* HORACE W. STUNKARD, New York University.

Presidential address.

41. *A Method of Obtaining Clean Suspensions of Cysts of* Endamoeba histolytica *from Culture.* Henry E. Meleney and Thomas L. Snyder, School of Medicine, Vanderbilt University.

A flask culture of *E. histolytica* containing a large number of cysts is shaken to suspend the sediment and the suspension is removed to sterile 50 cc centrifuge tubes. After repeated sedimentation, centrifugation and washing with sterile distilled or tap water the final sediment, consisting of cysts, fine rice particles and a few bacteria, is suspended in 2 cc of sterile zinc sulphate solution sp. gr. 1.13. This suspension is then transferred to a "flotation tube" containing 8 cc of zinc sulphate solution. The flotation tube is a pyrex glass tube 15 mm in diameter, with a capacity of 15 cc, a round bottom and a conical top terminating in a straight neck 4 cm in length and 4 mm in diameter. The tube is now filled with zinc sulphate solution half way up the neck. This is overlaid with 1 cm of sterile distilled water. The open end is covered with a small inverted sterile test tube which should not be long enough to touch the shoulder. The tube is then centrifuged at 2,500 revolutions for 5 minutes. The cysts collect at the junction of the zinc sulphate and water while the rice is driven to the bottom. The cysts can then be pipetted into sterile distilled water and washed to remove the zinc sulphate. We have obtained excystation of 12 per cent of the cysts after this manipulation, when planted in suitable media with bacteria.

42. Glugea microspora, *a New Microsporidian Species from the Liver of the Sand-Eel,* Amnodytes lanceolatus. Louis Van den Berghe, Institut Prince Leopold, Antwerp, Belgium.

Some years ago infections of *Amnodytes* with a supposed microsporidian were observed by M. Caullery, director of the Zoological Station at Wimereux. During one of my stays at the station, fixed material was submitted to me for study. Subsequent observations showed that the incidence of infection varies widely from one year to another. Macroscopically, infected livers show separate or confluent white spots near the surface. In sections, two conditions are observed: (1) definite localization of the parasites in spherical encysted masses, surrounded by normal liver tissue; or (2) generalized invasion of the liver cells, with one or two superficial layers of cells remaining normal. It is suggested that the first type represents an initial stage of infection; the second type, a terminal infection with overwhelming invasion of the liver cells. The parasite is identified as one of the Microsporidia. The ovoid spore is similar to that characteristic of the genus *Glugea,* species of which are mostly responsible for infections of fresh-water fishes; white nodules are produced in the tissues of these hosts. The spore measures 1.0–1.5 μ in length, as compared with 3–6 μ for other species. Hence, I propose the name *Glugea microspora* n. sp. for this parasite. Diagnosis: ovoid spores, 1.0–1.5 μ long; host, *Amnodytes lanceolatus;* habitat, liver; locality, Wimereux, pas de Calais, France.

43. *The Effects of Monochromatic Ultraviolet Radiation on Eggs of* Enterobius vermicularis. Myrna F. Jones, Leon Jacobs, and Alexander Hollaender, National Institute of Health.

Eggs of *Enterobius vermicularis,* the pinworm of man, were exposed to measured quantities of monochromatic ultraviolet radiation. The effects were determined by testing the ability of the eggs to hatch in artificial gastric juice. For the most part, eggs in the infective stage were used. Typical killing curves for single wavelengths will be shown. Wavelength dependence curves for fifty per cent killing from 2280 to 2950 Å will be exhibited. These dependence curves show a slight maximum for inactivation at wavelength 2805 Å and an increased sensitivity of the eggs at wavelengths below 2400 Å. Sublethal effects will be demonstrated, as follows: (1) A slower rate of hatch for irradiated eggs given considerable amounts of energy as compared with controls; (2) a delayed lethal effect evidenced after storage at various temperatures following irradiation; (3) a shorter survival time of larvae hatching from irradiated eggs; (4) a greater amount of damage to immature eggs as compared with infective-stage eggs.

44. *Demonstration of Ultraviolet Microscopy.* Peter A. Cole and F. S. Brackett, Washington Biophysical Institute and National Institute of Health.

Micro-photographs will be shown taken with a Zeiss ultraviolet microscope in the range 2144 Å to 4358 Å. Photographs of eggs of *Enterobius vermicularis* (pinworm) and spores of *Trichophyton mentagrophytes* at various wavelengths correlate nicely with the lethal action results of Hollaender, Jones and Jacobs, and Hollaender and Emmons. In the former case there is a maximum selective absorption at 2750 Å and in the latter at about 2600 Å. Both materials show a strong general absorption beginning at 2300 Å. Photographs of chromosomes of salivary gland of *Chironomus* sp. taken in cooperation with R. Boche of the Carnegie Institution of Washington demonstrate the possibility of obtaining good chromosomal contrast without staining, fixation, or even dissection of the chromosome from the cell or gland. Improvements in facilitating the use of the microscope have been made and will be discussed in a forthcoming paper.

45. *Further Studies on the Life Cycle of* Leptorhyncoides thecatus. D. L. DeGiusti, University of Michigan Biological Station and University of Wisconsin.

It has been found that when mature eggs of *L. thecatus* are fed to *Hyalella knickerbockeri* the larvae develop and become infective to fish in thirty-two days. Larvae thirty-two days old when fed to fingerling black bass become attached within the gastric ceca and undergo development. After a period of two months within the bass the larvae as yet have not become sexually mature. Larvae less than thirty days of age when fed to the bass become encysted in the mesenteries.

46. *The Anatomy of the Linguatulid,* Kiricephalus coarctatus (*Diesing*) *Sambon, 1910.* Carl E. Venard, Ohio State University.

Demonstration.

47. *Demonstration of a Species of Marine Piscicolidae from Florida.* Marvin C. Meyer, University of Kentucky.

Through the courtesy of Dr. Ross F. Nigrelli, of the New York Aquarium, I have been privileged to examine a total of sixty-six specimens of *Branchellion ravenelii* (Girard, 1850). The material was collected March 3, 1939 at Lemon Bay, Florida. Thirty-two were taken from the ventral external surface of *Dasyatis hastata* and the remaining twenty-four from *Amphotistius sabinus. B. ravenelii* is a marine Piscicolidae which is characterized especially by the possession of thirty-one pairs of lateral lamellar branchiae, eleven pairs of respiratory vesicles and the sharp demarcation of the body into a distinct trachlesome and urosome. Anatomical features of *B. ravenelii* will be shown by demonstration.

48. *The Glycogen Distribution in the Body of Acanthocephala.* Theodor von Brand. Barat College of the Sacred Heart, Lake Forest, Ill.

Sections of *Leptorhynchoides thecatus* and *Echinorhynchus coregoni* stained for glycogen are demonstrated. Compared to the results previously published for *Macracanthorhynchus hirudinaceus* some minor differences have been found. It is evident, however, that the glycogen distribution in the body of these three species is on the whole similar. A few points only may be mentioned here. The great importance of the subcuticula and the subcuticular lacunae system for the carbohydrate metabolism is again evident and all the muscles and muscular organs are extremely rich in glycogen. A surprisingly large amount of polysaccharide is stored in the region of the Embryonalkern of the embryos. It seems likely that the organs mentioned here will be found quite generally to be centers of polysaccharide deposition in Acanthocephala.

49. *Studies on the Life History of a Parasitic Copepod,* Lernaea carassii. Wilbur M. Tidd, Ohio State University.

A laboratory rearing method has been developed which has proven of sufficient merit to rear twenty-one successive generations of *L. carassii.* In this method small

goldfish have been used as hosts and the parasites reared at a controlled temperature of 28° C. Eight moults and nine stages have been demonstrated during the development. These consist of two naupliar, one metanaupliar and six copepodid stages. The sixth copepodid stage has not been demonstrated for the male. Complete development and egg production have been repeatedly obtained by the use of a single goldfish host. The life history has been found to consist of three phases: A free living phase, consisting of the naupliar, metanaupliar, and early first copepodid stages; a first parasitic phase in which the larvae complete the first, second, third, fourth and fifth copepodid stages while attached to the integument of the host; and a second parasitic phase in which the females burrow into the host tissues and undergo a marked metamorphosis. In this latter parasitic phase the body of the female lengthens from an average measurement of 1.358 to 9.780 mm. When reared at a controlled temperature of 28° C an average time of 450 hours was required for the completion of the life cycle. Fourteen hosts have been found which will accommodate the adult females of *L. carassii.*

50. Dioctophyme renale, *the Giant Kidney Worm Occurring in Mink, from the Southern Counties of Michigan.* Arthur E. Woodhead and Charles W. McNeil, University of Michigan.

Dioctophyme renale, the giant kidney worm, has been found in mink which apparently serves as a natural host in the southern counties of Michigan. Infection during the season of 1938–1939 was 8.6 per cent of all mink examined. Experiments are in progress to determine the possible method of transmission. Two male specimens have been found in the body cavity of mink. Only one case has been found involving the left kidney. Many viable eggs have been secured for experimentation. No evidence has been obtained, as yet, which would indicate that fish are involved in the life cycle.

51. *Effect of Age of Rat on the Size of* Trichinella *Infections.* E. H. Marchant, State University of Iowa.

Results of quantitative experimental studies seem to indicate that, as the rat grows older, it becomes more refractive to *Trichinella* infections. Rats, selected at ages of 3, 6, 12, 24 and 36 weeks were given doses of 320 or 640 larvae each or 20 larvae per gram weight of body. Eight weeks after infection each rat was killed, and the larvae, recovered from its muscles, were counted. It was found that, irrespective of the size of dose, the 3-week- and 6-week-old rats yielded more larvae than did those of 12, 24, and 36 weeks. In the case of those rats given 320 and 640 larvae each the average number of larvae recovered from the 12-week-old rats, was about 50 per cent of the number recovered from the 6-week-old rats, while in the 24-week-old rats the number was about 25 per cent of that obtained from the 12-week rats. In the rats 36 weeks of age the number was about 50 per cent of that recovered from the 24-week-old rats. When 20 larvae per gram weight of body were given to rats of 12, 24, and 36 weeks, the size of infections progressively decreased, despite the fact that the dosages increased.

52. *Sex Ratio of* Trichinella spiralis *from the Digestive Tract of Rats.* O. F. Gursch, State University of Iowa.

To determine the sex ratio of adult *Trichinella spiralis* a standard technique for recovery of the developing worms from the entire intestinal tract including stomach, cecum and excreta was utilized. A dose of 1280 larvae were given per os. Rats were killed at two-hour intervals up to 24 hours and daily thereafter until there were no more worms in the intestine. The examination of three rats infected two hours yielded 86.9 per cent of the original dose. Subsequent examinations at two-hour intervals yielded a decreasing percentage of worms up to the twelve-hour period. From fourteen hours up to and including the twelfth day the numbers of worms recovered were approximately 50 per cent of the original dose. After the twelfth day the adults disappear quickly. On the second day of intestinal infection

and thereafter the number of females and males were recorded separately and the sex ratio calculated. From the second to the eighth day inclusively an average sex ratio of 2.1 females to one male was obtained. On the ninth day the number of females decreased whereas the number of males remained comparatively constant. The average sex ratios from the ninth to the twelfth day were 1.3, 1.4, 1.2 and 1.3 females to one male.

53. *Recovery of* Trichinella spiralis *Larvae from Early Stages of Infection.* ARTHUR J. LEVIN, State University of Iowa.

By substituting a new method of maceration in place of pepsin digestion, it is possible to separate quantitatively *Trichinella spiralis* larvae from rat tissue in infections of from six days to fourteen days. Using a dose of 30 larvae per gram body weight administered per os, no larvae were recovered 5½ days after infection. However, on the sixth day, as many as 50,000 larvae were recovered, ranging in size from 95 μ to 105 μ in length by 3 μ wide, which is comparable to the size of larvae forced from a gravid female. From the seventh to the tenth day inclusive, the increase in numbers of larvae is marked; 149,000 larvae being recovered on the seventh day, 155,000 on the eighth day, 237,500 on the ninth day, and 330,000 on the tenth day. The numbers recovered thereafter remain relatively constant; 372,000 larvae on the eleventh day, a maximum of 415,000 on the twelfth day, 414,750 on the thirteenth day, and 401,250 on the fourteenth day. Daily measurements of the larvae indicate a very rapid growth, those of fourteen days' infection reaching a size of 105 μ to 315 μ (average 192 μ) in length by 7.5 μ to 22.5 μ (average 14.5 μ) in width. All the rats used were between the ages of eleven to twenty weeks.

54. *Schistosome Dermatitis: Distribution and Epidemiology in Michigan.* DONALD B. MCMULLEN, PAUL F. REZIN AND LEONARD ALLISON, Michigan Stream Control Commission and School of Medicine, University of Oklahoma.

In a survey of incidence of schistosome dermatitis, made during the summer of 1939, examinations of 139 beaches were made and complaints were received from 20 others that were not visited. Of the beaches examined 58, or nearly 42 per cent, were infested. Twenty-five of these beaches were treated in various ways with copper compounds in an attempt to find a cheap, practical method of control. Areas of greatest infestation coincide with the distribution of *Stagnicola emarginata,* which is plentiful north and west of Houghton Lake and in scattered areas in the Upper Peninsula. Three of the nine beaches reported south of Houghton Lake were examined. The dermatitis was caused by *Cercaria physellae.* The dermatitis in the other six beaches was probably of the same etiology, with the possible addition of *Cercaria elvae* and *Cercaria Schistomatium douthitti.* In the Keweenaw Peninsula most of the lakes are lined with "stamp sand." This contains copper and laboratory tests show that it is lethal to snails. Snails are scarce in this region and dermatitis is unknown. The life cycle of *Stagnicola emarginata* is also a factor. In some lakes the old generation of snails dies out during July. The new generation of snails does not become infected until the fall and spring migratory seasons so that there is little dermatitis after the middle of July. In other lakes, in some cases adjacent to those just mentioned, the infected generation of snails lives at least into September and prolongs the dermatitis season.

55. *Seasonal Variation in Emergence of Cotylocercous Cercariae.* CHARLES G. DOBROVOLNY, University of Michigan.

Observations on the emergence of cercariae from 43,189 snails of the species *Goniobasis livescens* were made from March through November of 1936 to 1938. In 49 collections of snails the incidence of emergence of cotylocercous cercariae ranged from 0.1 per cent to 5.0 per cent. There is a significant correlation between seasonal temperatures and emergence of cercariae of *Plagioporus lepomis* and non-cotylocercous cercariae. While the high peak of emergence of *C. lepomis* extends through July and August that of the cotylocercous *Cercaria dioctorenalis,* which encysts in

mayfly nymphs, occurs in late September and October. Application of statistical methods indicates that in the latter cercariae there is no correlation between temperature and emergence. Since all of these trematodes appear to have similar life cycles no explanation adequately accounts for this difference.

56. *Digenetic Trematodes of Fishes of the Galapagos Islands and Their Relationships.* HAROLD W. MANTER, University of Nebraska.

Of 39 species of Digenea collected from the Galapagos Islands, 21 species (all new) were endemic to the Galapagos. Of these 21 species, 8 have nearest related species in the region of Tortugas, Florida; 4 have nearest related species along the Pacific coast of Mexico; 3 have nearest related species in Japan; 2 have nearest related species in the northern American Pacific. In no case was a nearest related species found along the Pacific coast of South America (where an equal number of fishes were examined). Nearest related species were not clearly evident in the case of 4 species. Thus, a consideration of the endemic Galapagos species suggests closer relationship to the West Indian and Gulf of Mexico region than to any other. The 18 additional species collected from the Galapagos Islands are also known from other parts of the world. Ten of these species are known from Tortugas or the tropical American Atlantic; 6 were collected from the Pacific coast of Mexico; 3 from the Pacific South American coast. Five of the 18 species are known elsewhere only from the Tortugas region; 4 only from the Mexican Pacific; 1 only from Europe; 1 only from the Pacific South American coast. These figures indicate the same condition suggested by the 21 endemic species.

57. Diplostomum fosteri *n. sp. from a Panama Otter,* Lutra repanda *Goldman.* ALLEN MCINTOSH, U. S. Bureau of Animal Industry.

Over four thousand specimens of a small trematode belonging to the family Diplostomidae were collected by Dr. A. O. Foster and associates at the Gorgas Memorial Laboratory, Panama City, Panama. The parasites vary in size from small, immature individuals up to mature specimens 4.5 mm long. The hindbody is almost twice the length of the forebody. Oral sucker 120 μ by 110 μ, smaller than pharynx; lateral pseudo-suckers smaller than oral sucker; pharynx about 140 μ in diameter; acetabulum about 85 μ by 90 μ; tribocytic organ large, elliptical. Testes in middle third of posterior segment, divided into five lobes posteriorly; anterior testis 340 μ long by 480 μ wide by about 450 μ thick; posterior testis 350 μ long by 570 μ wide by 450 μ thick; seminal vesicle large, occupying most of space between posterior testis and copulatory bursa. Ovary ellipsoidal, 100 μ long by 340 μ wide by 100 μ thick, pretesticular; vitellaria extending from near level of anterior margin of tribocytic organ to cephalic margin of anterior testis. Oötype and vitelline reservoir situated between testes; Laurer's canal short, S-shaped. Uterus confined mostly to posterior segment, not penetrating tribocytic organ. Eggs about 100 μ by 60 μ, up to 100 present. The new species is similar to *Diplostomum alarioides* Dubois, 1937. The two species differ, however, in the distribution of the vitellaria. In *D. alarioides* the vitellaria extend to the copulatory bursa, while in *D. fosteri* they terminate at the cephalic margin of the anterior testis.

58. *Experimental Infection of European Starling with* Leucochloridium carus. ALLEN MCINTOSH, U. S. Bureau of Animal Industry, AND GERTRUDE E. MCINTOSH, Washington, D. C.

During the spring of 1939, sporocysts of two species of *Leucochloridium* were found in snails collected near Washington, D. C. In one instance two mature sporocysts of the red-brown type were obtained from *Succinea ovalis* Say, collected April 27, by J. C. Bridwell. On April 29, and on several occasions thereafter, infections with "green sporocysts" (Woodhead, 1935) were found in *Succinea retusa* Lea, collected from Potomac marshes near Mt. Vernon, Virginia. As many as 3 per cent of the snails collected were infected. After obtaining negative results with baby chicks fed metacercariae from both types of sporocysts, 3 snails containing viable

green sporocysts were fed to a fledgling starling, *Sturnus vulgaris* L., a few hours after the mollusks died. On May 27, seven days after feeding, the bird was killed and 64 *Leucochloridium*, too immature to permit specific determination, were recovered. On June 4, 9:00 AM, a young starling was given one *Succinea retusa* containing a green pulsating sporocyst or "brood sac" in each antenna; on June 8 a second snail containing one sporocyst was fed to this bird. Feces from the bird were negative for fluke eggs on June 12 and 13. On June 14, 9:00 AM, the bird was killed and 45 mature specimens of *Leucochloridium actitis* McIntosh, 1932, were recovered from the cloaca. Of the 6 or possibly 7 multicolored sporocysts known from America, the present case is the only one in which the flukes have been reared to maturity.

59. *The Life History of* Spelotrema nicolli (*Trematoda: Microphallidae*). R. M. Cable and A. V. Hunninen, Purdue University, Oklahoma City University and The Marine Biological Laboratory.

The cercaria of *Spelotrema nicolli* has been found to occur in the small marine snail, *Bittium alternatum* (Say). It is of the Ubiquita type and provided with two dissimilar pairs of cephalic glands on each side. The stylet measures 0.016 mm in length and is asymmetrical in lateral aspect. The excretory pattern is $2[(1+1)+(1+1)]$. The cercariae penetrate the gills of the blue crab, *Callinectes sapidus*, and pass by way of the blood stream to muscle-like fibers in which encystment occurs. The metacercariae grow until practically as large as the adults which they resemble closely except that eggs are lacking. The excretory pattern of older metacercariae is $2[(2+2)+(2+2)]$ and remains unchanged in the adult. Metacercariae from naturally infected crabs were fed to six young herring gulls from all of which numerous adult flukes were recovered after varying intervals. Six control birds were negative for *S. nicolli*.

60. *Studies on the Life History of Colorado Trematodes.* Wiley W. Crawford, Blackburn College.

Observations and experiments have been completed on the life cycles of two trematodes at the Rocky Mountain Biological Laboratory, Gothic, Colorado. (1) The life history stages of *Crepidostomum farionis* occurred in collections from beaver ponds as follows: ophthalomoxiphidiocercaria in the gills of the clam, *Pisidium* sp.; metacercaria encysted in the abdomen of mayfly naiads; adults in the intestine of the rainbow trout, *Salmo irideus*. Uninfected mayfly naiads collected from East River were infected with cercaria. Each of four trout, secured from a nearby fish hatchery, when fed these infected naiads yielded immature worms upon examination three weeks later. Each of four additional trout also yielded a large number of immature worms two to four weeks after having been heavily fed with the metacercaria in naturally infected mayfly naiads. (2) The life history stages of *Phyllodistomum americanum* occurred in collections from beaver and other ponds as follows: cystocercous cercaria in the clam *Pisidium* sp.; metacercaria encysted in damselfly naiads and caddice-fly larvae; adults in the urinary bladder of the mountain toad *Bufo boreas boreas*. Both damselfly naiads reared from eggs and uninfected caddice-fly larvae from East River ingested the large-tailed cercaria in the laboratory. A few days later recently encysted metacercariae were found adhering to the esophagus of each of the aquatic insects. Immature trematodes were also recovered from the urinary bladder of toads a few days after feeding them with either naturally infected damselfly naiads or caddice-fly larvae.

61. *Life History of* Triganodistomum mutabile (*Cort*): *Trematoda*. Harold E. Wallace, University of Michigan.

Cercariaeum mutabile (Cort, 1918, J. Parasitol. 5: 86–91) develops to maturity in the chub sucker, *Erimyzon sucetta oblongus* after feeding latter on *Chaetogaster limnaei*, experimentally infected with *C. mutabile*. Adult worms belong to the genus *Triganodistomum* Simer; the new combination is *Triganodistomum mutabile* (Cort).

The mature sausage-shaped rediae occur in the lining of the respiratory chamber of the snails, *Helisoma campanula* and *H. trivolvis*, immature rediae in the livers of these snails. Both *Planaria* sp. and *Chaetogaster limnaei*, in laboratory and in nature, eat the cercariae. These penetrate the gut wall and encyst in parenchyma and body wall respectively of these hosts, which in turn are eaten by the club sucker. Development of infective metacercariae requires forty days. Adult worms from the posterior third of the host's intestine, are about 1.5 mm long; body spinose; acetabulum larger than oral sucker. Prepharynx short, pharynx 0.082 mm long, esophagus medium. Crura extend almost to posterior end of body. Excretory bladder cylindrical, dorsal; pore subterminal, dorsal. Genital pore, on left margin at level of middle of acetabulum. Trilobed ovary and two testes in series close behind acetabulum. Vitelline follicles, six to eight on each side, extending from posterior margin of acetabulum to anterior margin of second testis; uterine coils filling posterior fifth of body. Eggs minute, numerous, operculate, 0.017 × 0.010 mm. This species resembles *T. translucens* (Simer), differing from it in size relations.

62. *Development of the Excretory System in* Cercariaeum mutabile (*Cort*): *Trematoda*. HAROLD E. WALLACE, University of Michigan.

The development of the excretory system of *Cercariaeum mutabile* (Cort), a tailless cercaria, was studied from germ-ball to mature worm. In the posterior third of the germ-ball this system first appears as two tubes which without flame cells grow anteriorly, turn laterally and posteriorly forming loops in the pharyngeal region. At this stage each tube can be seen to end in a flame cell, and suckers, pharynx and crura are well developed. A second pair of flame cells forms near the first ones and migrates anteriorly to the sides of the oral sucker. As development continues four, then eight, flame cells appear on each side, a total of 16 cells, each of which lies in an area later occupied by a group of four flame cells in the mature cercariaeum, the total being 64. Much as in *Plagioporus sinitsini* (Dobrovolny, 1939, Tr. Am. Micr. Soc. **58**: 121–153) the excretory bladder develops from the fusion of the primary excretory tubules and a mesodermal mass which forms coincidentally. The excretory tubes fuse posteriorly during the 2- and 4-flame cell stages forming a cylindrical vesicle with a single opening. Simultaneously with the fusing of the tubes they become embedded in the mesodermal mass of the bladder. Continued growth results in a long, cylindrical, heavy-walled, epithelial bladder opening subterminally on the dorsum. Many large cells around the pore secrete adhesive material.

63. *Life History of* Caecincola parvulus *Marshall and Gilbert* (*Trematoda: Heterophyidae*). WALTER S. LUNDAHL, University of Michigan.

A distomate pleurolophocercous cercaria from *Ammicola* (*Marstonia*) *lustrica* Pilsbry, Huron River near Ann Arbor, Mich., is shown to be the larva of *Caecincola parvulus* Marshall and Gilbert. The cercaria possesses eyespots, pharynx, weak acetabulum anterior to reproductive fundament, seven pairs of penetration glands, and special penetration spines in mouth and over anterior surface, smaller spines on remainder of body. Excretory bladder small, round, with long cornua; thick walls of both organs derived from mesodermal cell mass. Flame cell formula 2[(2+2)+(2+2)], as in adult. Tail long with dorsal, caudal, and bilobed ventral fins. Mature rediae sausage-shaped with short gut and no appendages. The life history of this species and morphology of its cercaria place it clearly in the Heterophyidae although the adult lacks a gonotyl. This confirms the judgment of Mueller and Van Cleave (1932, Roosevelt Wildlife Annals 3: 120) in placing *Caecincola* in the Heterophyidae with *Cryptogonimus* and certain other fish trematodes. Although resembling the unnamed heterophyid cercaria described by Hopkins (1938, J. Parasitol. **24** (Dec. Suppl.): 20), it differs from his species in possessing an acetabulum and in significantly different body measurements. Pumpkinseed sunfish, *Lepomis gibbosus*, have been experimentally infected with cercariae. Encystment takes place beneath the skin and in fins. Metacercariae are infective in about three weeks.

Adult worms have been recovered from the stomach, upper intestine, and pyloric ceca of large-mouthed bass, *Huro salmoides,* ten days after experimental feeding with metacercariae.

64. *Life History of* Spirorchis *sp. (Trematoda: Spirorchidae).* Limas D. Wall, University of Michigan.

The life history of *Spirorchis* sp., monostomate blood fluke, from arterioles of muscular gut wall of turtle, *Chrysemys picta,* has been solved. Eggs are large, oval, deep yellow, non-operculate, containing miracidia when passed from host, hatching after 4–6 days incubation at room temperature. Miracidia have 18 dermal plates in four rows, each with six, six, four and two plates, respectively, two pairs flame cells, lateral processes and pigmented eyespots. Mother sporocyst develops in lymph spaces along gut of snail hosts, *Helisoma trivolvis* and *H. campanulatum.* Daughter sporocysts elongate, sac-like, with six pairs of flame cells, birth pore terminal, cercarial germ-balls numerous. Cercariae are apharyngeal, brevifurcate, distomate resembling *Cercaria elephantis* and *C. wardi.* Body and tail spinose; body with dorsal fin, humped above insertion of tail, broad posteriorly, narrowed anterior to acetabulum. Eyespots pigmented, compound, circular, with lenses; mouth subterminal; esophagus long, ceca short, inflated; head gland dorso-median; oral sucker larger than acetabulum; tail stem muscular, more than twice length of body; furcae with dorso-ventral fin-folds. Bladder V-shaped; chief excretory ducts with ciliated patches; flame cell formula $2[(1+1+1)+(1+1+1)]$. Penetration glands seven pairs in immature cercariae from crushed snails, six pairs in free-swimming cercariae; reproductive fundament at posterior fifth of body. At room temperature worms become sexually mature 3½ months after infection.

65. *The Life History of an Apharyngeal Strigeid Trematode from Douglas Lake, Michigan.* Louis Olivier, New York University.

Strigeid cercariae emerging from *Planorbula armigera* (Say) and characterized by the unusual structure and activity of their tails (see abstract No. 1) penetrate tadpoles of *Rana pipiens* Schreber and *Hyla versicolor* LeConte. After two or three weeks development in the second intermediate host the metacercariae encyst in grape-like clusters about the heart and on the mesenteries. Development is continued for some time after encystment. The metacercariae are very similar to and may be identical with *Tetracotyle pipientis* Faust. The cercariae possess a pharynx but it appears to be lost during the metamorphosis in the metacercarial stage. No pharynx has been observed in mature, encysted larvae. Mature cysts, when fed to domestic pigeons, develop in the small intestine to adult apharyngeal trematodes belonging to the Strigeinae Railliet.

66. *Immunization of Birds to Malaria by Vaccination.* W. B. Redmond, Emory University.

Non-infected canaries have been immunized against infection with malaria by injecting parasites killed or attenuated in the red blood cells. Heavily infected blood was used for making the vaccine. The infected birds were etherized and the blood drawn from the jugular vein. After centrifugation the cells were placed in a heparinized solution of sodium citrate and urea. The tubes containing the suspension were sealed and placed in an ice bath containing enough potassium nitrate to lower the temperature to -3 to -4 degrees C. The cells were kept at this temperature for 73 hours to 96 hours. The treatment produced only slight hemolysis. The cells from one infected bird were injected intravenously into 2 of the experimental birds. The vaccine was injected every other day in most instances until 8 or more injections had been made. Normal birds injected from the experimental birds following the last dose of the vaccine revealed that all except 3 carried latent infections. No parasites had been found on examination previous to subinoculation, however. When these birds were injected with living parasites no typical infections occurred. Seven birds were completely immune as only an occasional parasite was found. Three birds were partially immune since a very

slight infection resulted. Normal birds injected at the same time showed typical infections.

67. *The Protective Action of Immune Serum Against* Plasmodium lophurae *in Chickens.* WILLIAM H. TALIAFERRO AND LUCY GRAVES TALIAFERRO, University of Chicago.

Serum from chickens immunized with *Plasmodium lophurae* (i.e., chickens which had an initial infection and had been reinfected with the same strain of parasites) exerts a protective action against infection in non-immune chickens which varies with the size and frequency of the serum treatments and the number of parasites given the test animals. More marked and stronger protection is secured if the parasitized erythrocytes are sensitized in vitro. After parasitized erythrocytes are incubated at 37° C for 2 hours with immune serum and after the serum is removed, these sensitized parasites initiate a lower grade infection which reaches its peak later than in control infections with parasites similarly treated with normal serum.

68. *The Reaction Between Hookworm,* Ancylostoma caninum, *Larvae and Immune Serum.* G. F. OTTO, Johns Hopkins University.

The reaction of hookworm larvae and immune serum first became evident within 5 hours after placing the larvae in such serum. This manifested itself as a thin granular precipitate at the oral opening and excretory pore. Usually such a precipitate could be seen at this time only with the aid of a microscope. The amount of precipitate increased during the next two days and often became bubble-like in appearance. During this period the activity of the larvae increased, apparently in an attempt to dislodge the adhering mass of precipitate. After the second day the larvae became progressively less active and the precipitate more extensive. It could be seen in the esophagous and sometimes in the intestine. In a few cases it was seen at the anal opening. By the fourth or fifth day the cuticula of unsheathed larvae showed evidence of injury. This most commonly appeared as bead-like swellings or bosses. Many larvae were dead by the fifth day and rarely has one remained alive, so far, beyond the seventh day.

69. *On the Transmission of Immunity to* Trichinella spiralis *from Parent to Offspring.* EVELYN ABRAMS MAUSS, Brooklyn College.

A series of experiments were conducted in which the offspring of trichinous animals were compared with the offspring of normal animals, with respect to their susceptibility to infection with *Trichinella spiralis.* It was found that in the offspring of infected rats, rabbits, and hamsters, the percentage development of infecting doses of trichina larvae was lower than in the offspring of uninfected animals. This lowered susceptibility to infection was lost by the hamsters as early as the third week after birth. The time before parturition of infection of the mother hamsters did not appear to influence the degree of immunity transmitted to the young. Examination for trichinae after complete digestion of the musculature of 5 rats, 5 rabbits, and 24 hamsters, all offspring of infected mothers, revealed not one case of prenatal infection. (The major part of this research was conducted at the Zoology Department of the University, Glasgow, Scotland.)

70. *Length of Life of Singly-Established* Strongyloides ratti. GEORGE L. GRAHAM, Rockefeller Institute for Medical Research, Princeton, New Jersey.

When *Strongyloides ratti* were established singly in laboratory rats there was considerable variation in the length of time that progeny were produced. Information on longevity was obtained from 78 single parasites. In each instance the last patent culture day was followed for 30 or more days by daily examinations which yielded no progeny. Basing length of life from the day of infection to the last patent day, the life span of these 78 infections ranged from 8 to 477 days with a mean of 149 ± 8 days. Cessation of reproduction in these infections occurred randomly. By grouping length of life data from these 78 parasites by 5

weeks intervals a slightly skewed, but nonetheless normal-type, frequency distribution was obtained. On the basis of available evidence this random termination of reproductive life appears in marked contrast to the constant rate of worm loss during the early course of mass infections or the precipitous loss which occurs when developing acquired resistance exerts its influence. During the patent period sequences of culture days occurred on which no progeny were produced. Analysis indicated chances of 9 to 1 that sequences of 14 days' duration would continue without producing progeny to 30 days rather than again becoming patent. With sequences of 21 days, this chance was 19 to 1. When patency was resumed after these periods, the yield of progeny was never comparable in numbers to yields from *re-infections* with a single parasite. No evidence of hyperinfection was obtained.

71. *On the Nature of Age Resistance to* Strongyloides ratti. H. J. Lawler, Johns Hopkins University.

Sheldon (1937, Am. J. Hyg. **26**: 355) demonstrated that older rats were more resistant to infection with *Strongyloides ratti* than rats two months old. His work was repeated, under slightly different conditions, and, in general, confirmed, as a preliminary to further study of the nature of "age resistance." The course of infection in 18 five-week old rats and 18 thirty-six-week old rats was followed by means of autopsies at 3, 7, 12, 20, 27, and 36 days after subcutaneous infection with 3000 larvae each. In the older animals the larvae took a significantly longer time to reach the intestine, and about one larva in ten molted in the lungs. The basic reason for these differences is not apparent. The older rats lost their worms much more rapidly, though having fewer to lose. The indication, thus, is that older animals develop a true acquired immunity much more rapidly than do younger ones. That this causes all the differences connoted by the term "age resistance" remains to be proven. Of interest here is the fact that other experiments indicate that the lethal dose of larvae for both age groups of animals, regardless of size and weight differences, is approximately the same.

72. *Allergic Skin Reactions in Human* Echinococcus *Infection with Antigens from Related Taenias.* James T. Culbertson and Harry M. Rose, College of Physicians and Surgeons, Columbia University.

Skin reactions were performed upon seven patients with proved echinococcus infection, using as antigen phenolized saline extracts of *Cysticercus pisiformis* from rabbits, and of *Taenia taeniaeformis* from cats. Several tests were carried out upon one patient with a polysaccharide of *Cysticercus crassicollis,* this polysaccharide being generously supplied by Dr. Dan H. Campbell of the University of Chicago. All of these persons were also skin-tested with human hydatid fluid for comparison. The reactions to these antigens were in all cases marked, with a large wheal, many pseudopods, pronounced itching, severe induration, and transitory erythema. The wheal usually reached 2 cm in diameter within 10 minutes, induration was noticeable in 15 minutes and persisted 12 to 36 hours. Reactions with hydatid fluid were less intense than with the other materials, the native hydatid antigen evidently being more dilute. In 13 hospitalized patients with non-parasitic disorders (e.g., cholelithiasis, abdominal and pulmonary tumors, rheumatic fever and asthma) and 20 normal persons, no significant reactions were observed, all being considered negative. Erythema was usual (this occurring, likewise, after the injection of physiological saline), but no wheals or pseudopods or induration was ever observed. Weak precipitin and complement-fixation reactions were obtained with serums from echinococcus patients when either hydatid fluid or rabbit cysticercus extract was used as antigen in these tests. These antigens also elicited skin reactions in rabbits with *Cysticercus pisiformis,* although not in normal rabbits. Stool examinations as well as histories of the echinococcus patients revealed no infection with intestinal taenias.

73. *The Intestinal Phase of the Immunity to* Cysticercus pisiformis *in Rabbits.* A. Byron Leonard and Alice E. Smith, University of Kansas.

Ova of *Taenia pisiformis* were freed from the proglottids, and immersed in 1 per cent trypsin in Tyrode's solution to which had been added 0.5 per cent dog bile and calcium carbonate to adjust the reaction to pH 7.3. The ova hatched in this solution at 37 degrees C. Normal and immunized animals were opened under anesthesia and about 2000 hatched onchospheres were injected into a branch of the mesenteric vein. The animals were killed on the seventh day after this operation. There was no significant difference between the number of larvae beginning development in the livers of the immunized animals as compared with the number of larvae developing in the livers of the normal animals. However, sections showed that in the immunized animals the larvae were killed by the tissue response of the host, while in the unimmunized animals the larvae were undergoing normal development. The conclusion drawn from these data is that the intestinal mucosa is the principal barrier in immunized animals. Data are summarized in tabular form, and photographs are submitted in evidence of the results.

74. *Immunity to Hookworm* (Bunostomum phlebotomum) *and Nodular Worm* (Oesophagostomum radiatum) *Infection in Calves.* Roy L. Mayhew, Louisiana State University.

Three calves have developed an immunity to mixed infections with the hookworm and nodular worm and one to a pure infection of nodular worms as judged by egg counts. Two of these animals remained resistant to inoculation with repeated doses of larvae while the immunity of the third was partially broken down as indicated by two slight increases in egg counts. One calf developed an immunity to a pure infection of nodular worms. The decreases in egg counts were associated with diarrhea in eleven of the thirteen instances and were associated with maturing of larvae of one or the other species in nine instances of the thirteen decreases in egg count. The initiation of the reaction apparently has no relation to the age of the animals in those cases studied as they ranged between approximately 6½ and 15½ months. Neither has the severity of the infection any relationship to the reaction since the average daily egg count preceding the decrease varied between 5.4 and 111 eggs per gram. The previous period of infection does not appear to have any influence on the reaction since the various calves had been infected between approximately 3 months and 12½ months before decreases in egg counts were obtained.

75. *Serological Reactions of Some Helminths.* Raymond W. Wilhelmi, New York University.

Analysis of precipitin reactions involving various stages in the life cycles of certain trematodes and cestodes revealed that larval and adult antigens are not serologically distinct and that serological recapitulation does not occur. Consistent results were obtained by injection of aqueous solutions containing forty milligrams of dried antigen from which the lipids had been removed. Preliminary removal of lipids from the desiccated antigen is necessary to exclude the possibility of group-specific reactions. Cross reactions with lipid-free antigens indicate that true specific relationships depend on differentiation of species-specific proteins but that modifications may result from the presence of type-specific polysaccharides. The reactions show that the trematode families Echinostomatidae and Heterophyidae are more closely related to each other than to the Plagiorchidae or the Paramphistomidae. A closer relationship was expressed by the reactions between Heterophyidae and Plagiorchidae than by tests involving the Heterophyidae and Paramphistomidae, and the kinship between Heterophyidae and Paramphistomidae was closer than that between Echinostomatidae and Paramphistomidae. A heterologus titer of 1:600 between *Moniezia expansa* and *Dipylidium caninum* denotes a close relationship between these two cestodes which is not equalled by the titer of either species with *Taenia taeniaformis* (1:60 with *Moniezia* and 1:100 with *Dipylidium*). The titers of all reactions in this series have been confirmed by reciprocal tests.

76. *Experimental Human Infection with* Sparganum mansonoides (*Mueller, 1935*). Justus F. Mueller and Fred Goldstein, New York State College of Forestry.

To determine whether the sparganum of *Diphyllobothrium mansonoides* Mueller, 1935, is capable of infecting man the authors introduced small spargana, approximately 3 mm long, under the skin of the left arm over the biceps, the senior author taking two, the junior author one. At the end of 9½ weeks the junior author had a large sparganum removed surgically from the connective tissue beneath the axilla, the worm having migrated about 4 inches from the site of injection. At the same time one sparganum was removed from the biceps of the senior author. Both worms were about 50 mm long. At the end of 14 weeks the second worm was recovered from the senior author and measured about 70 mm in length. It had migrated about 3 inches in the connective tissue. Symptoms observed during infection were periodic intense local urticaria, which on scratching developed into marked edema and erythema. These local attacks were accompanied by general feelings of profound depression. Pathologically the excised tissue consisted of necrotic changes in the region of the worm surrounded by dense infiltration of leucocytes characteristic of chronic inflammatory reaction. Encapsulation of the worms is imperfect however. Eosinophiles rose from 1 to 10 per cent and from 2 to 9 per cent in the two authors respectively. Rate of growth in man compares favorably with that determined for normal intermediate hosts such as the mouse. No proliferation occurred. The spargana recovered were fed to cats and developed into normal adults. The findings prove that *D. mansonoides* is a potential human parasite and suggest that this worm is responsible for the known cases of sparganosis reported for this country. Although it was not attempted, there is every reason to believe that oral infection in man with procercoids would also be successful. Since the worm is widespread and conditions for human infection simple, many other cases of natural human infection must occur which escape diagnosis and recording.

77. *A New Record of Human Heartworm Infection, from New Orleans.* Ernest Carroll Faust, Department of Tropical Medicine, Tulane University.

Dissection of the cadaver of an aged negress, native and life-time resident of New Orleans, revealed the presence of a small filiform worm in a blood clot in the inferior vena cava. The specimen has proved to be a complete male *Dirofilaria.* No female was found and no microfilariae were recovered from laked heart's blood clots. The worm is not *D. immitis,* common in dogs in New Orleans, and its characters do not correspond to those given for *D. magalhãesi,* although it is more nearly related to this species than to other species of *Dirofilaria.*

78. *Studies on the Survival of Eggs of* Enterobius vermicularis *under Known Conditions of Humidity and Temperature.* Myrna F. Jones and Leon Jacobs, National Institute of Health.

Investigations have been made on the survival of eggs of *Enterobius vermicularis,* the pinworm of man, under known conditions of relative humidity and temperature. For the most part, only eggs with infective-stage embryos were used. The criterion for survival was the subsequent ability to hatch active larvae in artificial gastric juice. In each experiment eggs were compared under the following conditions: (1) On a dry base, exposed to air, (2) on water at the same temperature as the dried eggs, (3) on water, at 3° to 5° C. Experimental conditions varied from dry to moist atmospheres at temperatures from 20° to 48° C. There was a definite reduction within 24 hours in survival of eggs exposed to humidities below 50 per cent at temperatures above 28° C. For example, less than 10 per cent survived 2 to 3 hours at a relative humidity of 38 to 41 per cent and a temperature of 36° to 37° C; none survived 16 hours under the same conditions, although 88 per cent of the eggs on water at the same temperature for 16 hours subsequently hatched. At the lower temperatures, 20° to 24½° C, but higher humidity, 62 to 91 per cent, 30 per cent of the eggs survived 6 days exposure. Of eggs kept on water at 3° to 5° C, a maximum of 93 per cent survived 18 days. A possible recovery of ability to hatch of eggs which were moistened after being dried and an increase in susceptibility to adverse conditions with age are discussed.

79. *The Blood Picture of White Mice Infected with* Trichinella spiralis. GEORGE W. HUNTER, III AND VINCENT GROUPÉ, Wesleyan University.

Seventeen albino mice from laboratory stock were infected with varying numbers of encysted *Trichinella spiralis* larvae and the blood picture studied over a period of seven weeks. No significant change was noted in the erythrocyte and total white blood count of moderately infected mice. The average differential blood count on six control mice yielded 65 per cent lymphocytes; 18.1 per cent neutrophils; 8.2 per cent monocytes; 4.4 per cent eosinophils; 1.4 per cent basophils. Groups of mice were fed 50, 100, 200, and 300 *Trichinella* cysts each. The basophils and monocytes showed no marked variation in numbers but the lymphocyte count dropped markedly during the first two weeks and then gradually increased. The eosinophils reached a high of 25 to 33 per cent and then dropped slightly to about 25 per cent. The neutrophils fluctuated slightly but did not increase markedly. In a single female fed 300 *Trichinella* larvae the lymphocyte count jumped from 63 to 77 per cent in ten days and then dropped to 51 per cent, gradually increasing thereafter. In this mouse the eosinophils gradually increased to a peak of 29 per cent throughout the period of observation. Whether this is atypical or characteristic of a heavier infection cannot be stated at this time. In general it appears that a moderate infection with *T. spiralis* in the albino mouse causes a moderate lymphopenia which is associated with a slight but distinct eosinophilia within the first two to three weeks of infection.

80. *The Penetration of Radioactive Phosphorus into Encysted* Trichinella *Larvae.* O. R. MCCOY AND VINCENT DOWNING, University of Rochester.

In three experiments, a total of 28 rats, heavily infected 8 to 10 months previously with *Trichinella spiralis,* were fed radioactive phosphorus (as basic sodium phosphate) and killed at intervals beginning 2 hours later. After removing 3-gram samples of muscle for analysis, each carcass was digested for 3 hours in artificial gastric juice. The larvae recovered were washed free from debris, desiccated and weighed. The amount of radioactive phosphorus present in the larvae was determined by means of a Geiger-Müller counting apparatus. Radioactive phosphorus was detected in the larvae as early as 2 hours after feeding. The amount increased rapidly during the first 24 hours, at which time it equalled the relative amount present in the muscle tissue. The maximal content was reached on the fourth day after which there was a gradual decline. After the first day, the relative amount of radioactive phosphorus present in the larvae was greater than that in the muscles. Suitable control experiments demonstrated that the larvae did not take up radioactive phosphorus during the process of digestion. Examination at the time the rats were killed showed that the larvae were enclosed in thick-walled cysts of connective tissue characteristic of long-standing muscle infection. No calcification was observed, however. The experiments indicate that a ready exchange of phosphate ions may take place through the cyst wall surrounding *Trichinella* larvae in the muscles, and imply that the larvae are probably undergoing active metabolism during the encysted stage.

81. *A Practical Plan for the Control of Trichinosis.* T. C. NELSON, Rutgers University.

Recent work of Hall and others confirms conclusions of Mark (1888) that trichinosis in hogs results from infected meat scraps in garbage. In the American cities of over 15,000 population surveyed, 50 per cent dispose of garbage through hogs. The incidence of approximately 17 per cent of trichinae in human diaphragms as reported by Hall and others is less than half that shown by recent study of 100 cadavers each at Cleveland, O., and Birmingham, Ala. Suggested measures of control of trichinosis in hogs and thus of humans by complete federal inspection or by boiling of garbage are expensive, inadequate, or difficult to enforce. The intradermal test of Bachman and of Augustine and Theiler was applied during 1938–1939 by Lichterman and Kleeman of the New York City Department of Health to garbage fed hogs of the municipal piggery. Of 211 swine skin tested 25 were diagnosed

as positive. On corroborative digestion of all the diaphragms an accuracy of 97 per cent was demonstrated. Only one hog, very lightly infected, escaped detection. This test is practicable, can be applied at all slaughter houses at a cost not over fifty cents a hog, probably much less. Farmers may secure test by State or Federal inspectors for home slaughtering. All positively reacting hogs should be refrigerated. Universal adoption of this test would largely eliminate trichinosis in five years.

82. *Progress Report on Pasture Rotation and the Prevalence of the Helminth Parasites of Sheep in Southwest Virginia.* W. L. Threlkeld, Virginia Agricultural Experiment Station, Blacksburg, Virginia.

The project herein reported deals with a study of helminth parasites of sheep raised in Southwest Virginia. In previous years, the work has been confined to the biology of *Ostertagia circumcincta.* In this connection, experiments to date indicate that the infective larvae of *Ostertagia circumcincta* in this section of Virginia may remain viable and infective in paddocks of miscellaneous growth for a period of twelve months. The lowest temperature recorded is minus 10 degrees F. Monthly precipitation and temperatures are recorded. The study of a modification of Mönnig's method for the treatment of nodular worms has been in progress for three years, and will be continued. Results so far obtained by the method employed show an efficiency of 78.5 per cent in directing certain anthelmintics to the abomasum. Determination of the prevalence of the different parasites in the sheep raised in this section of the state are made from examinations of the various organs at the abattoir; and following these, the alimentary tract is washed, contents screened, and specimens preserved for future identification. One hundred and twenty animals are under observation at the present time. The frequency of various species of helminth parasites is indicated below according to the order in which they are listed. Approximate percentages of parasites present: *Haemonchus contortus,* 59.4; *Trichostrongylus* species, 5.0; *Cooperia curticei,* 10.0; *Ostertagia circumcincta,* 6.2; *Oesophagostomum columbianum,* 1.7; *Nematodirus* species, 11.0; *Trichuris ovis,* 0.4; *Moniezia* species, 0.04; *Bunostomum trigonocephalum,* 0.1; *Chabertia ovina,* 0.02; *Cooperia oncophora,* 0.4; *Cooperia punctata,* 0.2, and *Strongylus papillosus,* 0.4.

83. *Phenothiazine as an Anthelmintic.* Paul D. Harwood, Robert T. Habermann, and Leonard E. Swanson, U. S. Bureau of Animal Industry.

The first results of tests with phenothiazine as an anthelmintic in swine were published in 1938 (J. Parasitol. **24** (Dec. Suppl.) : 16). Since that time phenothiazine, prepared for use as an insecticide, was tested as an anthelmintic in pigs and sheep, the dose rate being 0.5 to 1.0 gram per pound of live weight. The treatment removed 5 per cent of 44 immature *Ascaris,* 62 per cent of 345 mature *Ascaris,* and 92 per cent of 5,162 *Oesophagostomum* species from 22 pigs. At the same dose rates the drug removed 77 per cent of 328 *Bunostomum* and 91 per cent of 928 *Oesophagostomum* from 8 sheep. In 16 experiments recrystallized phenothiazine at a dose rate of 0.1 to 0.25 gram per pound of body weight removed 19 per cent of 251 immature *Ascaris,* 59 per cent of 197 mature *Ascaris,* and 92 per cent of 625 *Oesophagostomum* from swine. At similar dosages the recrystallized drug removed 61 per cent of 833 *Bunostomum* and 90 per cent of 775 *Oesophagostomum* from 14 sheep. These results suggest that phenothiazine, prepared for use as an insecticide, is much less effective than the recrystallized product. Doses of 25 grams of recrystallized phenothiazine per sheep removed 95 per cent of 449 *Bunostomum,* 84 per cent of 81 *Oesophagostomum,* and 94 per cent of 32 *Chabertia* from 6 sheep. Five of these sheep were also infected with *Haemonchus* or with *Ostertagia,* as determined by fecal examination. At necropsy a total of only 1 immature *Haemonchus* and 60 *Ostertagia* were recovered from 3 of the sheep, the other two being negative.

84. *Changes Occurring in Blood of Chickens During Cecal Coccidiosis.* C. A. Herrick, University of Wisconsin.

Changes in the blood picture were found to start on the fifth day of infection with the advent of hemorrhage. With the onset of hemorrhage there was a reduction of erythrocytes and hemoglobin, a decrease in total and non-protein-nitrogen, a depletion of liver and muscle glycogen, a loss in blood volume and a reduced metabolic rate. Concomitant with these changes there was an increase in the sugar and sodium chloride content of the blood which rose progressively from the fifth through the seventh day of infection. During this period the osmotic pressure of the blood was found to remain relatively constant.

85. *The Effect of Sulfapyridine on Experimental Avian Coccidiosis.* P. P. Levine, New York State Veterinary College.

Sulfapyridine, when fed to chickens in the proportion of 0.7% of the mash, had a marked coccidiostatic effect on *E. praecox, E. mitis* and *E. hagani.* The total number of oöcysts discharged by the control birds during the first 8 days of the experiments was 70, 89, and 11 times greater, respectively, than that of the treated birds. When, after this time, the sulfapyridine was withdrawn, the number of oöcysts discharged increased and reached a peak 5 days later. In no case was this peak as high as that of the controls. Sulfapyridine had no effect on the course of infections with *E. tenella* or *E. necatrix.* The effect of sulfapyridine on avian coccidia was quite similar to that of sulfanilamide (Levine, 1939, Cornell Vet. **29**: 309). The former compound was non-toxic for the birds while the latter was definitely toxic.

86. Capillaria *Infection of the Lower Digestive Tract of the Common Fowl* (Gallus domesticus). Neal F. Morehouse, Dr. Salsbury's Laboratories, Charles City, Iowa.

During the past year, one or more species of *Capillaria* were collected from the lower digestive tract of chickens received in 44 shipments from 13 different states. In this survey, *Capillaria caudinflata* (Molin) syn: *C. longicollis* (Rud.) was found in chickens received from Iowa, Minnesota, Ohio, Illinois, Wisconsin, Pennsylvania, Missouri, Kansas, Indiana and Michigan. *Capillaria columbae* was found in chickens from Minnesota, Ohio, Illinois, Wisconsin, Pennsylvania, Maryland, Rhode Island and Georgia. Ohio, however, was the only state from which *Capillaria retusa* was received. This appears to be the first published record of *Capillaria caudinflata* occurring anywhere in the United States. *Capillaria columbae* and *Capillaria retusa* are reported for the first time as follows: *Capillaria columbae*—Minnesota, Ohio, Illinois, Wisconsin, Rhode Island and Georgia; *Capillaria retusa*—Ohio.

87. *Actual State of Human Hepatic Distomosis in Cuba. Diagnosis and Treatment.* Pedro Kourí and José G. Basneuvo, Institute of Tropical Medicine, University of Havana.

Two liver flukes cause human hepatic distomosis in Cuba: *Fasciola hepatica,* a native parasite, and *Clonorchis sinensis,* an imported one. The first human case of hepatic fasciolosis in Cuba was reported in 1931 (Kourí and Arenas). From that time on, we have reported 35 human cases. From 22 to 49% of the Chinese population of Cuba suffer from clonorchiasis. Hepatic fasciolosis is a chronic disease, of slow evolution, characterized by digestive and hepatobiliary troubles, interrupted by acute crises with fever. At times, the troubles are slight or unnoticed, especially when the disease begins. Liver and gall bladder troubles are, at times, intensive (angiocholecystitis, hepatic colics, jaundice, etc.). Some patients show loss of weight and strength, and become pale. Slight anemia, and eosinophilia ranging from 6.5 to 32% may occur during the septic stage of the disease (30,000 leukocytes per cmm). Several cases show gastric, appendicular, nervous and psychic troubles (Kourí and associates). The above mentioned symptoms are doubtless due to *Fasciola hepatica,* and do not disappear until the specific treatment is administered. *Fasciola hepatica* is frequently reported in cattle. *Lymnaea cubensis* and *Physa cubensis* are its intermediate hosts in Cuba (Vigueras and

Moreno). The diagnosis is made by the microscopic examination of feces and of the bile obtained by duodenal drainage (Kourí's technique). Kourí and associates have determined the specific treatment, which is emetine hydrochloride, administered in a total dose of ½ centigram per kilogram of body weight (4 centigrams a day). Fifty-three cases have been cured with this drug, of whom 20 were treated in Cuba.

88. *Studies on the Bovine Blood Picture in Hookworm* (Bunostomum phlebotomum) *and Nodular Worm* (Oesophagostomum radiatum) *Infections.* ELAINE T. DELAUNE AND ROY L. MAYHEW, Louisiana State University.

Studies on the erythrocyte, leucocyte and differential cell values have been made on two calves infected with nodular worms and three infected with hookworms and nodular worms. In both types of infection there was a decrease in the erythrocyte and an increase in the leucocyte counts as compared with the preinfection periods on the same animals and with controls kept concurrently under the same management. The period of observation and the number of counts made on each individual were as follows: No. 95, 5 months, 30 counts; No. 90, 14 months, 66 counts; No. 91, 15 months, 65 counts; No. 89, 10 months, 40 counts; No. 85, 12 months, 66 counts. The observations obtained seem to indicate that a left shift in the neutrophilic count is associated with a rise in the total white cells and a drop in the red cells. There is also a drop in percentage of lymphocytes correlated with a rise in the stab neutrophiles. A greater range was obtained in all counts made on infected animals as compared with controls and with those made on the same animal during the preinfection period. The same blood changes were also obtained in a naturally infected Brahman heifer. Data are presented on the blood picture of normal healthy castrated males on pasture and cows in the Louisiana State University dairy herd for comparison with the experimental animals.

89. *Anthelmintic Efficacy of Unconditioned Crude Phenothiazine.* ROBERT T. HABERMANN AND PAUL D. HARWOOD, U. S. Bureau of Animal Industry.

Data now in press indicate that recrystallized phenothiazine is a more effective anthelmintic than phenothiazine prepared for use as an insecticide. Since recrystallized phenothiazine is more expensive, it seemed advisable to ascertain whether the crude chemical without a conditioning agent designed to adapt it to insecticidal purposes would be as effective as the recrystallized product. Twenty-five grams of crude phenothiazine administered experimentally to each of 5 sheep resulted in the elimination of 94 per cent of a total of 99 *Oesophagostomum,* 67 per cent of 82 *Bunostomum* and 100 per cent of 3 *Chabertia.* The drug removed all of the *Bunostomum* present in 4 of the sheep tested, but only 7 out of a total of 34 present in 1 sheep that was in very poor condition apparently due to severe oesophagostomiasis. No significant difference in effectiveness was found between the crude phenothiazine used in these experiments and recrystallized phenothiazine. A total of 716 *Haemonchus* and 420 *Ostertagia* were eliminated from these 5 sheep following treatment, 12 immature *Haemonchus* and 460 *Ostertagia* being found at necropsy. Probably the number of *Haemonchus* and *Ostertagia* eliminated represented only a fraction of the total worms killed by the drug. Three of the 5 sheep were heavily infected with *Trichostrongylus* spp. and 236, 219, and 3,129 of these worms were eliminated, 2,870, 30, and 340 *Trichostrongylus,* respectively, being recovered at necropsy. The first animal, in which the drug was relatively ineffective for the removal of *Trichostrongylus,* suffered severely from oesophagostomiasis.

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BISHOPP, FRED C., B.S., M.S. (Colorado Agricultural College, 02, 26), Ph.D. (Ohio State, 32), *Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, District of Columbia.*

BLACK, JAMES J., D.V.M. (Kansas State College, 23), Associate Poultry Pathologist, *New Jersey State Poultry Laboratory, Vineland, New Jersey.*

BOARDMAN, EDWARD THORPE, B.S., M.S. (Florida, 28, 29), Sc.D. (Johns Hopkins, 33), Zoologist, Cranbrook Institute of Science, Collaborator, University of Michigan Museum of Zoology, *Cranbrook Institute of Science, Bloomfield Hills, Michigan.*

BOND, FRANKLYN FOSTER, B.S. (Cornell, 34), Sc.D. (Johns Hopkins, 37), Student Fellow in Bacteriology, *School of Medicine and Dentistry, University of Rochester, Rochester, New York.*

BOUGHTON, DONALD C., B.S. (Pittsburgh, 26), M.S. (Minnesota, 28), Ph.D. (Wisconsin, 32), Associate Protozoologist, Bureau of Animal Industry, U. S. Department of Agriculture, *P. O. Box 952, Auburn, Alabama.*

BOYD, GEORGE H., A.B., M.S. (Emory, 17, 22), Sc.D. (Johns Hopkins, 24), Professor of Zoology and Chairman of Division of Biological Sciences, *University of Georgia, Athens, Georgia.*

BOYD, MARK F., M.D., M.S. (Iowa, 11, 13), C.P.H. (Harvard, 14), Field Staff, International Health Division, Rockefeller Foundation, *P. O. Box 793, Tallahassee, Florida.*

BRACKETT, STERLING, B.A., M.A. (Minnesota, 35, 37), Research Assistant, Department of Zoology, *University of Wisconsin, Madison, Wisconsin.*

BRADBURY, ORA C., B.S. (Ottawa, Kansas, 14), A.M., Ph.D. (Nebraska, 15, 19), Professor of Biology, *Wake Forest College, Wake Forest, North Carolina.*

BRADY, FREDERICK J., M.D. (Michigan, 31), Passed Assistant Surgeon, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

BRANCH, HAZEL E., B.A., M.A. (Kansas, 08, 12), Ph.D. (Cornell, 21), Professor of Zoology and Head of Department, *University of Wichita, Wichita, Kansas.*

BRANDT, BARTHOLOMEW B., B.S. (Mississippi Agricultural and Mechanical College, 17), A.M., Ph.D. (Duke, 24, 35), Professor of Biology, *East Carolina Teachers' College, Greenville, North Carolina.*

BRECKENRIDGE, CARLYLE G., A.B., M.A. (Alabama, 30, 31), Assistant Professor of Zoology, *University of Alabama, University, Alabama.*

BRODY, ARTHUR LOUIS, B.S., Ph.D. (Cornell, 28, 35), Assistant Entomologist, *U. S. Bureau of Entomology, P. O. Box 508, Valdosta, Georgia.*

BROOKE, MARION MURPHY, A.B., M.A. (Emory, 35, 36), Student Assistant, Department of Protozoology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

BROOKS, FRANK G., B.S. (Allegheny College, 15), A.M. (Oklahoma, 22), Sc.D. (Johns Hopkins, 28), Professor of Biology, *Cornell College, Mount Vernon, Iowa.*

BROWN, HAROLD W., A.B. (Kalamazoo College, 24), M.S. (Kansas State College, 25), Sc.D. (Johns Hopkins, 28), M.D. (Vanderbilt, 33), D.P.H. (Harvard, 36), Professor of Preventive Medicine, University of North Carolina and Duke University Medical School, *Chapel Hill, North Carolina.*

BROWNE, PATRICK, Technician, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

BYRD, ELON E., B.S., M.S. (Mississippi State College, 29, 31), Ph.D. (Tulane, 34), Assistant Professor of Zoology, *University of Georgia, Athens, Georgia.*

Caballero y Caballero, Eduardo, M.S. (National University of Mexico, 34), *Instituto de Biologia, Chapultepec Casa del Lago, Mexico, D.F., Mexico.*

Cable, Raymond Millard, A.B. (Berea College, 29), M.S., Ph.D. (New York University, 30, 33), Associate Professor of Parasitology, *Purdue University, Lafayette, Indiana.*

Cahn, Alvin R., B.S. (Cornell, 13), M.S. (Wisconsin, 15), Ph.D. (Illinois, 22), Chief, Biological Readjustment Division, *Tennessee Valley Authority, Norris, Tennessee.*

Cameron, Alne E., V.S. (Ontario Veterinary College), Chief Veterinary Inspector, *231 Sunnyside Ave., Ottawa, Canada.*

Cameron, Donald, B.S.A. (McGill, 33), Ph.D. (Cornell, 39), Assistant in Zoology, *Cornell University, Ithaca, New York.*

Cameron, John A., A.B., A.M. (Nebraska, 25, 26), Ph.D. (Missouri, 34), Assistant Professor of Zoology, *University of Missouri, Columbia, Missouri.*

Cameron, Thomas W. M., M.A., B.Sc., D.Sc. (Edinburgh, 21, 21, 26), Ph.D. (London, 23), Research Professor of Parasitology and Director, *Institute of Parasitology, MacDonald College, McGill University, Montreal, Canada.*

Canning, Graeme A., B.S. (Northwestern, 23), A.M. (Columbia, 24), Ph.D. (Chicago, 28), Associate Professor of Zoology and Parasitology, *University of Tennessee, Knoxville, Tennessee.*

Carroll, Matthew E., Jr., A.B., A.M. (Kansas, 21, 22), Instructor in Biology, *Lincoln Junior College, Kansas City, Missouri.*

Carroll, Mitchel, B.S., Ph.D. (Pennsylvania, 15, 19), Professor of Biology and Chairman of the Department, *Franklin and Marshall College, Lancaster, Pennsylvania.*

Carter, Thomas Chauncey, A.B. (Northwestern State Teachers' College, 19), A.M. (Colorado State Teachers' College, 20), Ph.D. (Wisconsin, 30), Chairman, Department of Biology, *Northwestern State Teachers' College, Alva, Oklahoma.*

Causey, Ottis R., B.S. (Clemson College, 27), Sc.D. (Johns Hopkins, 31), Staff Member, *International Health Division, Rockefeller Foundation, Caixa Postal 49, Rio de Janeiro, Brazil.*

Chandler, Asa Crawford, A.B. (Cornell, 11), M.S., Ph.D. (California, 12, 14), Professor of Biology, *Rice Institute, Houston, Texas.*

Chandler, Everett R., B.S. (Mount Union College, 29), *239 Virginia Avenue, Chester, West Virginia.*

Chandler, Wallace Larkin, B.S., M.S. (California, 14, 15), Ph.D. (Cornell, 18), Assistant Professor and Research Associate in Parasitology, Michigan State College; Consultant in Parasitology, *Michigan Department of Health, 626 Abbott Road, East Lansing, Michigan.*

Chang, Kwei, M.S. (University of Shanghai, China, 30), Ph.D. (Iowa State College, 37), Professor of Biology, *Cheeloo University, Chengtu, Szechwan, China.*

Chen, Pin-dji, A.B. (Ginling College, China, 28), M.A. (Michigan, 32), *Ginling College, West China University, Chengtu, Szechwan, China.*

Chitwood, B(enjamin) G., B.A. (Rice Institute, 28), M.S., Ph.D. (George Washington, 29, 31), Associate Nematologist, *Bureau of Plant Industry, U. S. Department of Agriculture, Babylon, New York.*

Chitwood, May Belle (Mrs.), Collaborator, Bureau of Plant Industry, *U. S. Department of Agriculture, Babylon, New York.*

Christensen, John F., B.S. (Utah State Agricultural College, 31), Ph.D. (California, 35), Associate Protozoologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

Christenson, Reed O., B.S. (Utah State College, 26), M.A., Ph.D. (Minnesota, 28, 33), Department of Zoology and Entomology, *Alabama Polytechnic Institute, Auburn, Alabama.*

Christie, Jesse Roy, B.S. (Kentucky, 14), M.S. (Illinois, 18), Ph.D. (George Washington, 34), Nematologist, *Bureau of Plant Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

CLARK, HERBERT C., M.D. (Pennsylvania, 06), Director, *Gorgas Memorial Laboratory, P. O. Box 5025, Ancon, Canal Zone.*

CLARK, ROBERT DENHOLME, A.B. (Tennessee, 37), Parasitologist, Research Department, *Ralston-Purina Company, St. Louis, Missouri.*

CLEVELAND, LEMUEL R., B.S. (Mississippi, 17), Sc.D. (Johns Hopkins, 23), Associate Professor of Zoology, *Harvard University, Cambridge, Massachusetts.*

COATNEY, G. ROBERT, A.B. (Grand Island College, 25), M.A. (Nebraska, 26), Ph.D. (Iowa State College, 32), Protozoologist, *U. S. Public Health Service, P. O. Box 1344, Columbia, South Carolina.*

COLLINS, RALPH K., B.S. (Kansas State College, 19), M.D. (Johns Hopkins, 22), Field Director, International Health Division, Rockefeller Foundation, *School of Hygiene, Ministry of Hygiene, Ankara, Turkey.*

CORT, WILLIAM WALTER, A.B. (Colorado, 09), A.M., Ph.D. (Illinois, 11, 14), Professor of Helminthology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

COVENTRY, FRANCES A., A.B. (Goucher College, 20), Sc.D. (Johns Hopkins, 24), *School Lane Hills, Lancaster, Pennsylvania.*

*CRAIG, CHARLES F., M.D., A.M. (Hon.) (Yale, 94, 14), *239 West Lullwood Ave., San Antonio, Texas.*

CRAM, ELOISE BLAINE, B.S. (Chicago, 18), M.S., Ph.D. (George Washington, 22, 25), *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

CRAWFORD, WILEY W., A.B., M.A. (Missouri, 25, 28), Ph.D. (Minnesota, 34), Professor of Biology and Chairman of Department, *Blackburn College, Carlinville, Illinois.*

CROSS, SAMUEL X., A.B. (Nebraska State Teachers' College, 28), M.S., Ph.D. (Wisconsin, 32, 33), Assistant Zoologist, Bureau of Animal Industry, U. S. Department of Agriculture, *6401 University Avenue, Chicago, Illinois.*

CUCKLER, ASHTON CLINTON, A.B., A.M. (Nebraska, 35, 36), Teaching Assistant, Department of Zoology, *University of Minnesota, Minneapolis, Minnesota.*

CULBERTSON, JAMES THOMAS, B.S. (William and Mary, 26), M.A. (Cornell, 30), Ph.D. (Columbia, 33), Assistant Professor of Bacteriology, *College of Physicians and Surgeons, Columbia University, New York, New York.*

CURTIS, WINTERTON C., A.B., A.M., Sc.D. (Hon.) (Williams, 97, 98, 34), Ph.D. (Johns Hopkins, 01), Professor of Zoology, *University of Missouri, Columbia, Missouri.*

DANIEL, GEORGE E., S.B. (Arkansas, 28), Sc.D. (Johns Hopkins, 31), Assistant Professor of Parasitology, Live Stock Sanitary Service, *University of Maryland, College Park, Maryland.*

DAVIS, HERBERT S., Ph.B. (Wesleyan, 99), Ph.D. (Harvard, 07), Fish Pathologist in Charge of Aquaculture Investigations, *U. S. Bureau of Fisheries, Washington, District of Columbia.*

DEGIUSTI, DOMINIC LAWRENCE, B.S. (St. Thomas College, 36), M.S. (Michigan, 38), Fellow in Veterinary Science, University of Wisconsin, *315 S. Brooks St., Madison, Wisconsin.*

DEHNBOSTEL, NELLIE GWYNNE, B.Mus., M.Mus. (Dana's Musical Institute, 36, 39), A.B. (Kent State University, 39), *178 Iddings Avenue, Warren, Ohio.*

DENNIS, E. WESTERVELT, A.B. (Oklahoma City University, 27), M.A., Ph.D. (California, 29, 31), Associate Professor of Bacteriology and Parasitology, and Chairman of the Department, *The American University of Beirut, Beirut, Syria.*

DENTON, JAMES FRED, B.S., M.S. (Georgia, 35, 38), Fellow in Biology, *Rice Institute, Houston, Texas.*

DERBYSHIRE, RUSSEL CLAY, B.S., M.S. (Kansas State College, 30, 31), Ph.D. (Iowa State College, 38), Instructor in Zoology, *Municipal University of Omaha, Omaha, Nebraska.*

DERIVAS, DÁMASO, B.S., M.S., Ph.D., M.D. (Pennsylvania, 08, 09, 10, 10), Professor of Parasitology, *University of Pennsylvania Medical School, 1831 Chestnut St., Philadelphia, Pennsylvania.*

DICKERMAN, E. EUGENE, B.A. (Grand Island College, 26), M.A., Ph.D. (Northwestern, 31, 36), Assistant Professor of Biology, *Bowling Green State University, Bowling Green, Ohio.*

DOBROVOLNY, CHARLES G., B.A. (Montana, 28), M.S. (Kansas State College, 33), Ph.D. (Michigan, 38), Instructor in Zoology, *University of Michigan, Ann Arbor, Michigan.*

DONALDSON, ALAN WESTON, B.S. (Mount Union, 38), Graduate Student, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

DOVE, WALTER E., B.S. (Mississippi Agricultural and Mechanical College, 13), Sc.D. (Johns Hopkins, 27), Principal Entomologist in Charge of Screw Worm Control, *U. S. Bureau of Entomology, 707 Thorpe Building, Minneapolis, Minnesota.*

DRAKE, CARL J., B.S., B.Pd. (Baldwin-Wallace College, 12), Ph.D. (Ohio State, 21), Professor and Head of Department of Zoology and Entomology, *Iowa State College, Ames, Iowa.*

EARLE, WALTER C., B.S. (Chicago, 18), M.D. (Rush Medical College, 20), Field Staff, International Health Division, Rockefeller Foundation, *Apartado Postal 11, Cuernavaca, Morelos, Mexico.*

ELLIS, JOHN M., A.B., M.S. (Emory, 24, 26), Ph.D. (California, 34), Professor of Biology, *Junior College of Augusta, Augusta, Georgia.*

ENDERS, HOWARD E., B.S., M.S. (Lebanon Valley College, 97, 00), B.S. (Michigan, 98), Ph.D. (Johns Hopkins, 06), Dean of School of Science, Head of Department of Biology and Professor of Zoology, *Purdue University, West Lafayette, Indiana.*

ERICKSON, ARNOLD B., B.S., M.A. (Minnesota, 35, 37), Junior Entomologist, *Division of Entomology and Economic Zoology, University of Minnesota, St. Paul, Minnesota.*

ESSEX, HIRAM E., B.S. (Knox College, 19), M.S., Ph.D. (Illinois, 24, 27), Associate Professor of Physiology, *The Mayo Foundation, University of Minnesota, Rochester, Minnesota.*

EWING, HENRY E., A.B., A.M. (Illinois, 06, 08), Ph.D. (Cornell, 11), Entomologist, *U. S. National Museum, Washington, District of Columbia.*

FAUST, ERNEST C., A.B. (Oberlin, 12), M.A., Ph.D. (Illinois, 14, 17), Professor of Parasitology, Department of Tropical Medicine, *Tulane University School of Medicine, New Orleans, Louisiana.*

FELDMAN, SEYMOUR IRVING, A.B. (Minnesota, 38), Teaching Assistant in Zoology, *University of Minnesota, Minneapolis, Minnesota.*

FERGUSON, MALCOLM S., B.A., M.A. (University of Western Ontario, 32, 34), Ph.D. (Illinois, 37), Research Fellow, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

FISCHTHAL, JACOB H., B.S. (Long Island, 37), M.S. (Iowa, 38), Graduate Student, Department of Zoology, *University of Michigan, Ann Arbor, Michigan.*

FISH, FREDERICK F., B.S. (Cornell, 28), Sc.D. (Johns Hopkins, 31), Associate Aquatic Biologist, U. S. Bureau of Fisheries, *2725 Montlake Blvd., Seattle, Washington.*

FLORENCE, LAURA, M.A., B.Sc. (Aberdeen, Scotland, 07, 09), A.M. (Stanford, 16), Ph.D. (Cornell, 20), Associate Professor of Bacteriology, *New York Homeopathic Medical College and Flower Hospital, New York, New York.*

FOSTER, AUREL OVERTON, B.A., M.A. (Wesleyan, 29, 30), Sc.D. (Johns Hopkins, 33), Assistant Parasitologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

FREDINE, C. GORDON, B.S. (Hamline University, 32), *1807 Wesley Ave., St. Paul, Minnesota.*

GABALDON, ARNOLDO, Ph.B., M.D. (Universidad Central de Venezuela, 28, 30), Sc.D. (Johns Hopkins, 35), Jefe, Division de Malariologia, *Direccion de Salubridad Publica, Ministerio de Sanidad y Asistencia Social, Caracas, Venezuela, South America.*

GARCIA-DIAZ, JULIO, B.S., B.A. (Puerto Rico, 21, 22), M.S., Ph.D. (Cornell, 27, 36), Professor of Biology and Dean, College of Arts and Sciences, *University of Puerto Rico, Rio Piedras, Puerto Rico.*

GEIMAN, QUENTIN MONROE, B.S. (Gettysburg College, 27), M.S., Ph.D. (Pennsylvania, 31, 34), Instructor in Protozoology, *Harvard Medical School and School of Public Health, 25 Shattuck St., Boston, Massachusetts.*

GIBBS, CHARLES SHELBY, B.S. (Bates, 16), M.S. (Yale, 20), Ph.D., D.V.M. (Michigan, 21, 29), Poultry Pathologist, *Lederle Laboratories, Pearl River, New York.*

GINGRICH, WENDELL, A.B. (North Central College, 26), Sc.D. (Johns Hopkins, 30), Associate Professor, Department of Bacteriology and Preventive Medicine, *University of Texas Medical School, Galveston, Texas.*

GLASER, R(UDOLPH) W., A.B. (Michigan, 11), Sc.D. (Harvard, 14), Associate Member, Department of Animal and Plant Pathology, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

GOLDHAFT, TEUIS M., D.V.M. (Cornell, 35), Laboratory Director, *Vineland Poultry Laboratory, Vineland, New Jersey.*

GONZALEZ-MARTINEZ, ISAAC F., Licenciate in Medicine (Barcelona, 97), Doctor in Medicine (Madrid, 00), Graduated Radiologist (Paris, 20), Pres. Liga Puertorriquena Contra el Cancer, Chief Roentgoenological Clinic, Diaz Garcia Hospital, *Allen #86, San Juan, Puerto Rico.*

GOODNIGHT, CLARENCE, A.B., A.M., Ph.D. (Illinois, 36, 37, 39), Assistant in Zoology, *University of Illinois, Urbana, Illinois.*

GOWER, W. CARL, B.Ed. (Southern Illinois Teachers' College, 32), M.S. (Louisiana State, 34), Ph.D. (Michigan State College, 37), Biologist-in-charge, *Swan Creek Wildlife Experiment Station, Allegan, Michigan.*

GRAHAM, GEORGE LAURIN, A.B. (Grand Island College, 27), M.S. (Kansas State College, 30), Sc.D. (Johns Hopkins, 33), Associate, Department of Animal and Plant Pathology, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

GRAHAM, JOHN Y., B.S., M.S. (Princeton, 92, 94), Ph.D. (Munich, 97), Professor of Biology, *University of Alabama, University, Alabama.*

GRILL, JOHN C., M.D. (Vienna, 21), Associate Professor of Pathology and Bacteriology, *School of Medicine, Marquette University, Milwaukee, Wisconsin.*

GUBERLET, JOHN E., A.B. (Bethany College, Kansas, 09), A.M., Ph.D. (Illinois, 11, 14), Professor of Zoology, *University of Washington, Seattle, Washington.*

GURSCH, OTTO F., B.A. (Iowa), Graduate Student, University of Iowa, *802 East Washington St., Iowa City, Iowa.*

GUSTAFSON, PAUL VICTOR, B.S. (Whitworth College, 36), M.S. (Illinois, 37), Head of Department of Biology, *Whitworth College, Spokane, Washington.*

HAGER, ANNE, B.S., M.S. (Iowa State College, 32, 34), Instructor in Zoology, *Iowa State College, Ames, Iowa.*

HALL, RICHARD P., A.B. (Henderson-Brown College, 19), A.M., Ph.D. (California, 22, 24), Associate Professor of Biology, *New York University, University Heights, New York.*

HAMANN, CECIL BOYCE, B.S. (Taylor University, 37), Graduate Assistant, Department of Biology, *Purdue University, West Lafayette, Indiana.*

HANNUM, C(LAIR) A., B.S., M.S. (University of Washington, 23, 24), Assistant Professor of Zoology, University of Arizona, *Box 4012, University Station, Tucson, Arizona.*

HANSON, HENRY, A.B., A.M. (South Dakota, 02, 11), M.D. (Johns Hopkins, 08), *care of U. S. Consulate, Asuncion, Paraguay.*

HARKEMA, REINARD, A.B. (Calvin College, 32), Ph.D. (Duke, 35), Instructor in Zoology, *North Carolina State College, University of North Carolina, Raleigh, North Carolina.*

HARTMAN, ERNEST, B.S., M.S. (Kansas State College, 22, 24), Sc.D. (Johns Hopkins, 26), Assistant Professor of Bacteriology and Clinical Pathology, *University of Vermont College of Medicine, Burlington, Vermont.*

HARWOOD, PAUL D., B.S. (Cornell, 28), M.A., Ph.D. (Rice Institute, 30, 31), Associate Parasitologist, Zoological Division, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

HATHAWAY, EDWARD STURTEVANT, A.B. (Cincinnati, 09), A.M., Ph.D. (Wisconsin, 21, 25), Professor of Zoology, *Tulane University, New Orleans, Louisiana.*

HAZARD, FRANK O., A.B. (Wilmington College, 27), M.S., Ph.D. (Ohio State, 29, 37), Professor of Zoology, *Wilmington College, Wilmington, Ohio.*

HEADLEE, WILLIAM HUGH, A.B. (Earlham College, 29), M.S. (Illinois, 33), Ph.D. (Tulane, 35), Instructor in Biology, *Purdue University, Lafayette, Indiana.*

HEARIN, JAMES T., B.S., M.S. (Louisiana State, 35, 37), Student Assistant, Department of Helminthology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

HEDRICK, LESLIE R., A.B. (Illinois, 26), Ph.D. (Michigan, 32), Head of Biology Department, Lewis Institute, *1951 W. Madison Ave., Chicago, Illinois.*

HEGNER, ROBERT, B.S., M.S. (Chicago, 03, 04), Ph.D. (Wisconsin, 08), Professor of Protozoology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

HERBER, ELMER CHARLES, A.B. (Ursinus College, 25), M.A. (Pennsylvania, 29), Instructor in Biology, *Dickinson College, Carlisle, Pennsylvania.*

HERMAN, CARLTON, B.S. (Michigan, 32), M.S. (Syracuse, 35), Sc.D. (Johns Hopkins, 38), Research Associate, *New York Zoological Park Laboratory and Hospital, 185th Street and Southern Boulevard, New York, New York.*

HERMS, WILLIAM B., B.S., Sc.D. (Hon.) (Baldwin-Wallace College, 02, 35), M.A. (Ohio State, 06), Professor of Parasitology and Head of Division of Entomology and Parasitology, *University of California, Berkeley, California.*

HERRICK, C. A., B.S., M.S. (Kansas State College, 21, 23), Sc.D. (Johns Hopkins, 25), Associate Professor of Zoology and Veterinary Science, *University of Wisconsin, Madison, Wisconsin.*

HERTIG, MARSHALL, B.S., Ph.D. (Minnesota, 16, 21), Assistant Professor of Medical Entomology, Harvard Medical School, Boston, Massachusetts, and Jefe del Departamento de Entomologia Medica, Instituto Nacional de Higiene y Salud Publica, Lima, Peru. *Care of American Consulate, Lima, Peru, South America.*

HETHERINGTON, DUNCAN CHARTERIS, A.B. (Colorado College, 18), A.M., Ph.D. (Illinois, 20, 22), M.D. (Johns Hopkins, 36), Associate Professor of Anatomy, *Duke University, Durham, North Carolina.*

HEWITT, REDGINAL I., B.S. (Allegheny College, 32), M.S. (Syracuse, 36), Sc.D. (Johns Hopkins, 38), Instructor in Protozoology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

HIGHBY, PAUL R., A.B. (Luther College, 29), M.A. (Minnesota, 30), Department of Biology, *Luther College, Decorah, Iowa.*

HILL, CHARLES H., A.B. (Johns Hopkins, 32), Junior Parasitologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

HILL, HOWARD R., A.B. (Carroll College, 13), M.S. (Illinois, 16), Ph.D. (Southern California, 37), Curator of Zoology, *Los Angeles Museum, Exposition Park, Los Angeles, California.*

HILL, ROLLA B., B.S. (Whitman College, 12), M.D. (Pennsylvania, 17), D.P.H. (Johns Hopkins, 30), Field Staff, International Health Division, Rockefeller Foundation, *P. O. Box 398, Lisbon, Portugal.*

HINMAN, E. HAROLD, B.A. (Queen's University, Canada, 27), M.S., Ph.D. (Cornell, 28, 30), M.B., M.D. (Louisiana State, 37, 38), Senior Biologist, *Division of Malaria Studies and Control, Tennessee Valley Authority, Wilson Dam, Alabama.*

HIYEDA, KENTARO, M.D. (Manchuria Medical College), Professor of Pathology and Parasitology, *Manchuria Medical College, Mukden, Manchoukuo.*

HOBMAIER, MICHAEL, D.V.M. (Munich, 18), Associate Professor of Comparative Pathology, *Hooper Foundation for Medical Research, University of California, San Francisco, California.*

HOEPPLI, REINHARD J. C., M.D. (Kiel, Germany, 19), Sc.D. (Hamburg, Germany, 24), Professor of Parasitology, *Peiping Union Medical College, Peiping, China.*

HOFFMAN, WILLIAM ALBERT, B.S. (Cornell, 17), Sc.D. (Johns Hopkins, 24), Assistant Professor of Parasitology, *School of Tropical Medicine, San Juan, Puerto Rico.*

HOGUE, MARY JANE, A.B. (Goucher College, 05), Ph.D. (Würzburg, 09), Associate in Anatomy, *University of Pennsylvania, Medical School, Philadelphia, Pennsylvania.*

HOLL, FREDERICK J., B.S. (Buffalo, 22), M.S. (Wisconsin, 26), Ph.D. (Duke, 28), Associate Professor of Zoology, *University of Buffalo, Buffalo, New York.*

HOPKINS, SEWELL HEPBURN, B.S. (William and Mary, 27), M.A., Ph.D. (Illinois, 29, 33), Assistant Professor of Biology, *Texas Agricultural and Mechanical College, College Station, Texas.*

HORSFALL, MARGERY W., B.A. (Reed College, 28), M.A., Ph.D. (Illinois, 30, 34). *165 Delmar Road, Rochester, New York.*

HOUGHTON, HENRY S., Ph.B., Sc.D. (Hon.) (Ohio State, 01, 34), M.D. (Johns Hopkins, 05), LL.D. (Hon.) (Hongkong, 25), Acting Director, *Peiping Union Medical College, Peiping, China.*

HSIUNG, T. S., Ph.D. (Iowa State College), *Szechuan Provincial Bureau of Animal Industry, South Gate, Chengtu, Szechuan, China.*

HSU, DORIS YIN-MING, B.A. (Hwa Nan College, Foochow, China, 28), M.A., Ph.D. (Michigan, 32, 35), Dean of *Hwa Nan College, Foochow, China.*

HUDSON, A. EDWARD A., (Albert Memorial College, England), Superintendent, *Waynesboro General Hospital, Waynesboro, Virginia.*

HUDSON, CHARLES BANNUS, B.S., M.S. (Kansas State College, 24, 27), Assistant Poultry Pathologist, *New Jersey Experiment Station, New Brunswick, New Jersey.*

HUFF, CLAY G., A.B. (Southwestern College, 24), Sc.D. (Johns Hopkins, 27), Associate Professor of Parasitology, Secretary, Department of Bacteriology and Parasitology, *University of Chicago, Chicago, Illinois.*

HUFF, GEORGE C., B.S. (Drake, 28), M.S., Ph.D. (Iowa, 29, 35), Professor of Biology and Head of Department, *Drake University, Des Moines, Iowa.*

HUGHES, R. CHESTER, B.A. (Oklahoma, 22), M.S., Ph.D. (Michigan, 27, 28), Associate Professor of Zoology, *Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

HUIZENGA LEE S., M.D. (New York Homeopathic Medical College, 13), C.P.H., D.P.H. (Yale, 28, 29), *382 Avenue Joffre, Shanghai, China.*

HUMES, ARTHUR G., B.A. (Brown, 37), M.S. (Louisiana State, 39), Graduate Student, Department of Zoology, *University of Illinois, Urbana, Illinois.*

HUNNINEN, ARNE V., A.B., A.M. (Wesleyan, 31, 32), Sc.D. (Johns Hopkins, 35), Professor of Biology, *Oklahoma City University, Oklahoma City, Oklahoma.*

HUNTER, GEORGE W., III, B.S. (Knox College, 23), M.S., Ph.D. (Illinois, 24, 27), Assistant Professor of Biology, *Wesleyan University, Middletown, Connecticut.*

HUNTER, WANDA S. (MRS.), A.B. (Wisconsin, 26), M.S. (Illinois, 27), Denison Research Assistant in Biology, *Wesleyan University, Middletown, Connecticut.*

IRIARTE, DAVID R., M.D. (Caracas, Venezuela, 28), Jefe de Trabajos Prácticos de la Cátedra de Bacteriologia i Parasitologia de la *Universidad Central, Clinica Razetti, Los Caobos, Caracas, Venezuela.*

JACOBS, WILLIAM F., M.D. (Buffalo), Associate Professor of Pathology, Attending Pathologist, *Buffalo City Hospital, 408 Richmond Ave., Buffalo, New York.*

JAMES, WILLIAM M., M.D. (Virginia, 06), Chief of Medical Clinic, *Hospital de Panama and Herrick Clinic, 12 Avenue Central, Panama, Republic of Panama.*

JELEN, GEORGE D., D.V.M., M.S. (Ohio State, 23, 33), Bureau of Animal Industry, *U. S. Department of Agriculture, 318 Livestock Exchange Building, Pittsburgh, Pennsylvania.*

JELLISON, WILLIAM L., B.S. (Montana State College, 29), M.S. (Minnesota, 33), Assistant Parasitologist, *Rocky Mountain Laboratory, U. S. Public Health Service, Hamilton, Montana.*

JERSTAD, ARTHUR CLIFFORD, B.S., D.V.M. (State College of Washington, 33), Assistant Veterinarian, U. S. Food and Drug Administration, Zoological Divi-

sion. *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

JOHNSON, FRANCIS B., M.D. (Medical College of the State of South Carolina, 03), Professor of Clinical Pathology, *Medical College of the State of South Carolina, Charleston, South Carolina.*

JOHNSTONE, HERBERT G., A.B., M.A., Ph.D. (California, 27, 28, 33), Instructor in Bacteriology, *University of California Medical School, San Francisco, California.*

JONES, E. ELIZABETH, A.B., Ph.D. (Radcliffe College, 20, 30), A.M. (Maine, 24), Assistant Professor of Zoology, *Wellesley College, Wellesley, Massachusetts.*

JONES, MYRNA F., A.B. (Doane College, 24), M.S. (Illinois, 26), Ph.D. (George Washington, 32), Zoologist, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

KADNER, CARL GEORGE, B.S. (San Francisco, 33), M.S. (California, 36), Associate Professor of Biology, *Loyola University of Los Angeles, Los Angeles, California.*

KEANE, ROGER H., Ph.G., B.S. (State College of Washington, 25, 28), M.D. (Oregon, 33), *Medical-Dental Building, Portland, Oregon.*

KELLEY, RUTH SHAW (MRS.), A.B., A.M. (Kansas, 27, 28), Ph.D. (Pittsburgh, 34), *614 West Main St., Kent, Ohio.*

KERR, JOHN A., B.S., M.D. (Northwestern, 24), Field Staff, International Health Division of the Rockefeller Foundation, *Caixa Postal 49, Rio de Janeiro, Brazil.*

KERR, KATHEL B., A.B. (Oberlin College, 29), M.S. (Washington University, St. Louis, 31), Sc.D. (Johns Hopkins, 36), Junior Zoologist, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

KESSEL, JOHN F., A.B. (Greenville College, 19), A.M., Ph.D. (California, 21, 23), Professor of Bacteriology and Parasitology, *School of Medicine, University of Southern California, Los Angeles, California.*

KHAW, OO-KEH, M.B., Ch.B. (Edinburgh), D.T.M. (Liverpool), D.P.H. (Cambridge), D.T.H. (Tropen Institut), Assistant Professor of Parasitology, *Peiping Union Medical College, Peiping, China.*

KILLEEN, JOHN ANACLETUS, Student, *Depauw University, Greencastle, Indiana.*

KING, WILLARD V., B.S. (Montana State College, 11), Ph.D. (Tulane, 15), Senior Entomologist, Bureau of Entomology and Plant Quarantine, *U. S. Department of Agriculture, Box 491, Orlando, Florida.*

KIRBY, HAROLD, JR., B.S. (Emory, 22), A.M., Ph.D. (California, 23, 25), Associate Professor of Zoology, *University of California, Berkeley, California.*

KIRBY-SMITH, J. LEE, M.D., Sc.D. (University of the South, 06, 27), Practising Dermatologist, *Greenleaf and Crosby Building, Jacksonville, Florida.*

KOFOID, CHARLES A., A.B., Sc.D. (Hon.) (Oberlin, 90, 15), A.M., Ph.D. (Harvard, 92, 94), D.Sc. (Hon.) (Wales, 20), LL.D. (Hon.) (California, 37), Emeritus Professor of Zoology, *University of California, Berkeley, California.*

KOHLS, GLEN M., B.S. (Montana State College, 29), M.S. (Minnesota, 37), Assistant Entomologist, *U. S. Public Health Service, Hamilton, Montana.*

KOONZ, CARL H., B.A. (Carroll College, 31), M.A., Ph.D. (Northwestern, 34, 37), Research Laboratory, *Swift and Company, Union Stock Yards, Chicago, Illinois.*

KOURÍ-ESMEJA, PEDRO, M.D. (Havana, 25), Professor of Parasitology and Tropical Medicine, Director, Institute of Tropical Medicine, *University of Havana, Havana, Cuba.*

KOWALCZYK, STANLEY A., A.B. (Temple University, 33), M.A. (Pennsylvania, 35), Graduate Student, University of Pennsylvania, *825 Newmarket St., Philadelphia, Pennsylvania.*

KRUIDENIER, FRANCIS, B.S., M.S. (Michigan, 36, 37), Graduate Student, *University of Michigan, Ann Arbor, Michigan.*

KUDO, RICHARD R., D.Sc. (Tokio), Associate Professor of Zoology, *University of Illinois, Urbana, Illinois.*

LAAKE, ERNEST WILLIAM, B.S. (Texas Agricultural and Mechanical College, 13), Ph.D. (Iowa State College, 33), Senior Entomologist, Bureau of Entomology and Plant Quarantine, *U. S. Department of Agriculture, P. O. Box 208, Dallas, Texas.*

LANDSBERG, J. W., Ph.G., B.S. (Maryland, 30, 34), Sc.D. (Johns Hopkins, 38), Parasitologist and Hematologist, *Warner Institute for Therapeutic Research, 113 West 18th St., New York, New York.*

LANGE, MATHILDE M., Ph.D. (Zürich, Switzerland, 19), Professor of Zoology, *Wheaton College, Norton, Massachusetts.*

LARSH, JOHN E., JR., A.B. (Illinois, 39), Graduate Student, *Department of Zoology, University of Illinois, Urbana, Illinois.*

LARSON, MARY E., A.B., A.M. (Kansas, 19, 22), Assistant Professor of Zoology, *University of Kansas, Lawrence, Kansas.*

LA RUE, GEORGE R., B.S. (Doane College, 07), M.A. (Nebraska, 09), Ph.D. (Illinois, 11), Professor of Zoology and Chairman of the Department, *University of Michigan, Ann Arbor, Michigan.*

LAWLER, HARRY JAMES, B.S. (Illinois, 36), Assistant, Department of Helminthology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

LEADINGHAM, ROY SAMUEL, M.D. (Creighton, 07), F.A.C.P., Associate in Medicine, *Emory University, 384 Peachtree St., Atlanta, Georgia.*

LEIGH, W. HENRY, A.B. (Greenville College, 34), M.A. (Illinois, 35), Wright Junior College, *3400 North Austin Ave., Chicago, Illinois.*

LEONARD, A. B., B.S. (Central Teachers' College, Oklahoma, 31), M.A., Ph.D. (Kansas, 33, 37), Department of Zoology, *University of Kansas, Lawrence, Kansas.*

LEROUX, PHILIPPUS L., B.S. (Edinburgh), Member of the Royal College of Veterinary Surgeons, *Veterinary Research Station, Marabuka, Northern Rhodesia, South Africa.*

LEVINE, PINCUS PHILIP, B.S. (College of the City of New York, 27), M.S., D.V.M., Ph.D. (Cornell, 32, 32, 37), Instructor, *New York State Veterinary College, Cornell University, Ithaca, New York.*

LINCICOME, DAVID RICHARD, B.S., M.S. (Illinois, 37), Assistant in Parasitology, Department of Tropical Medicine, *Tulane University School of Medicine, New Orleans, Louisiana.*

LOEWEN, SOLOMON L., A.B. (Tabor College, 23), A.M. (Minnesota, 28), Professor of Biology and Head of Department, *Sterling College, Sterling, Kansas.*

LUCAS, MIRIAM SCOTT, B.S., Ph.D. (Pennsylvania, 24, 27), *Iowa State College, Ames, Iowa.*

LUCKER, JOHN L., B.S. (University of Washington, 22), M.A. (George Washington, 38), Associate Zoologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

LUDLOW, ALFRED I., A.B. (Adelbert College, Western Reserve University), M.S., M.D. (Western Reserve), D.Sc. (Hon.) (College of Wooster), Professor of Surgery and Director of Research, *Severance Union Medical College, Seoul, Chosen (Korea).*

LUTTERMOSER, GEORGE W., A.B. (Wayne University, 33), Sc.D. (Johns Hopkins, 37), Junior Parasitologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

LYFORD, HELEN STEWART, A.B. (Mount Union College, 33), Sc.D. (Johns Hopkins, 39), *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

LYNCH, JAMES E., A.B., A.M. (Nebraska, 17, 21), Ph.D. (California, 29), Associate Professor of Fisheries, *School of Fisheries, University of Washington, Seattle, Washington.*

LYNCH, KENNETH MERRILL, M.D. (Texas, 10), LL.D. (Hon.) (South Carolina, 30), Professor of Pathology and Vice-Dean, *Medical College of the State of South Carolina, Charleston, South Carolina.*

LYON, MARCUS WARD, JR., Ph.B. (Brown, 97), M.D., Ph.D. (George Washington, 02, 12), Pathologist, *South Bend Clinic, South Bend, Indiana.*

MACKIN, J. G., B.S. (East Central State Teachers' College, Oklahoma, 24), M.S., Ph.D. (Illinois, 27, 33), Professor of Biology, *East Central State Teachers' College, Ada, Oklahoma.*

MacLulich, D(uncan) A., B.Sc.F., Ph.D. (Toronto, 31, 37), Ranger, Algonquin Park Staff, *144 Mavety St., Toronto, Canada.*

Macy, Ralph William, B.A. (Linfield College, 29), M.A., Ph.D. (Minnesota, 31, 34), Professor of Biology, *College of St. Thomas, St. Paul, Minnesota.*

Magath, Thomas Byrd, Ph.B. (Emory, 13), M.S. (James Millikin, 14), Ph.D., M.D. (Illinois, 17, 19), Head of Section on Parasitology, Mayo Clinic, Professor, Pathology and Parasitology, *Mayo Foundation, University of Minnesota, Rochester, Minnesota.*

Mangrum, James F., B.S. (State Teachers' College, Memphis, Tennessee, 31), M.S. (Tennessee, 36), Instructor in Zoology, *Lincoln Memorial University, Harrogate, Tennessee.*

Manter, Harold W., B.A. (Bates College, 22). M.A., Ph.D. (Illinois, 23, 25), Professor of Zoology, *University of Nebraska, Lincoln, Nebraska.*

Manwell, Reginald Dickinson, A.B., A.M. (Amherst, 19, 26), Sc.D. (Johns Hopkins, 28), Professor of Zoology, *Syracuse University, Syracuse, New York.*

Marin, Rafael A., S.B. (Harvard, 23), M.D. (Columbia, 32), Practising Physician, Assistant Physician, City Hospital, New York, Clinical Assistant, Mt. Sinai Hospital, *15 West 110 St., New York, New York.*

Mark, E(dward) L., A.B., LL.D. (Hon.) (Michigan, 71, 96), Ph.D. (Leipzig, 76), LL.D. (Hon.) (Wisconsin, 04), Emeritus Professor of Anatomy, Harvard University, *109 Irving St., Cambridge, Massachusetts.*

Marquez-Escobedo, Manuel B., M.D. (Escuela Medico-Militar, Mexico, 23), Health Officer, Mexican Department of Health, *Calle Colima 428, Mexico, Distrito Federal, Mexico.*

Martin, H. M., D.V.M. (Pennsylvania, 16), A.M., Ph.D. (Nebraska, 23, 27), Associate Professor of Veterinary Pathology and Parasitology, *University of Pennsylvania, Philadelphia, Pennsylvania.*

Martin, Walter Edwin, B.Ed. (Northern Illinois State Teachers' College, 30), M.S., Ph.D. (Purdue, 32, 37), Assistant Professor of Zoology, *DePauw University, Greencastle, Indiana.*

Matheson, Robert, B.S., M.S., Ph.D. (Cornell, 06, 07, 11), Professor of Entomology, *Cornell University, Ithaca, New York.*

Mauss, Evelyn Abrams, A.B. (Minnesota, 36), Substitute Tutor, *Brooklyn College, Brooklyn, New York.*

Mayfield, Orley J., D.V.M. (Iowa State College, 28), Research on Poultry Diseases, *Charles City, Iowa.*

Mayhew, Roy L., B.S. (Iowa Wesleyan College, 14), M.A. (James Millikin, 17), Ph.D. (Illinois, 24), Parasitologist, Louisiana Experiment Station, and Assistant Professor of Veterinary Science, *Louisiana State University, University, Louisiana.*

Mazzotti, Luis, M.D. (University of Mexico, 25), C.P.H. (Johns Hopkins, 36), D.T.M. (Liverpool, England, 38), in charge of Laboratory of Helminthology, Institute of Tropical Diseases, *Agustin Melgar 30 dep 2, Mexico, Distrito Federal, Mexico.*

McCoy, Oliver R., A.B., M.S. (Washington University, St. Louis, 26, 27), Sc.D. (Johns Hopkins, 30), Assistant Professor of Parasitology, *School of Medicine and Dentistry, University of Rochester, Rochester, New York.*

McCulloch, Irene, A.B., A.M. (Kansas, 13), Ph.D. (California, 16), Professor of Zoology, Allan Hancock Foundation, *University of Southern California, Los Angeles, California.*

McFarlane, Samuel H., B.S. (Saskatchewan, Canada, 30), M.S., Ph.D. (Illinois, 31, 34), Professor of Biology, *Aurora College, Aurora, Illinois.*

McHugh, Robert A., A.B., (Lafayette, 35), Student Assistant in Entomology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

McIntosh, Allen, B.Sc. (Mississippi Agricultural and Mechanical College, 20), M.S. (Minnesota, 27), Associate Zoologist, Bureau of Animal Industry, *U. S. Department of Agriculture, Washington, District of Columbia.*

McMULLEN, DONALD B., B.S. (Tarkio College, 25), M.S. (Washington University, St. Louis, 28), Sc.D. (Johns Hopkins, 35), Assistant Professor of Bacteriology, Division of Parasitology, *University of Oklahoma Medical School, Oklahoma City, Oklahoma.*

McNAUGHT, JAMES B., A.B., A.M. (Kansas, 16, 17), M.D. (Stanford, 31), Assistant Professor of Pathology, *Stanford University School of Medicine, 2398 Sacramento St., San Francisco, California.*

MELENEY, HENRY E., A.B. (Dartmouth College, 09), M.D. (Columbia, 15), Associate Professor of Preventive Medicine and Public Health, *School of Medicine, Vanderbilt University, Nashville, Tennessee.*

MESERVE, FRANK G., A.B., Ph.D. (Nebraska, 21, 35), A.M. (Northwestern, 28), Associate Professor of Biology, *Macalester College, St. Paul, Minnesota.*

MEYER, MARTIN C., B.S. (Missouri, 32), M.A. (Ohio State, 36), Ph.D. (Illinois, 39), Instructor in Zoology, *University of Kentucky, Lexington, Kentucky.*

MICKLER, ROBERT H., Research Assistant, Department of Preventive Medicine, *University of Tennessee, Memphis, Tennessee.*

MIDDLETON, AUSTIN RALPH, A.B., Ph.D. (Johns Hopkins, 10, 15), Professor of Biology, *University of Louisville, Louisville, Kentucky.*

MILLER, EDWIN LYNN, B.S. (Iowa Wesleyan, 28), M.S., Ph.D. (Illinois, 30, 34), Associate Professor of Zoology, *Louisiana State University, University, Louisiana.*

MILLER, HARRY M., JR., B.S. (Ohio Wesleyan, 17), Ph.D. (Illinois, 23), Assistant Director for the Natural Sciences, *Rockefeller Foundation, 29 rue de la Baume, Paris (8), France.*

MILLER, MAX J., B.S. (Saskatchewan, 34), M.S. (McGill, 36), Ph.D. (Tulane, 39), Research Assistant, *Institute of Parasitology, Macdonald College, Quebec, Canada.*

MIZELLE, JOHN D., B.S., M.S. (Louisiana State, 32, 33), Ph.D. (Illinois, 37), Assistant Professor of Zoology, *Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

MOHR, JOHN L., A.B. (Bucknell, 33), Technician, Department of Zoology, *University of California, Berkeley, California.*

MÖNNIG, HERMANN OTTO, B.A. (Cape, 17), Ph.D. (Zürich, 21), B.V.Sc. (South Africa, 26), Professor of Parasitology, University of Pretoria and Research Officer, Division of Veterinary Services, *Department of Agriculture, Union of South Africa, Onderstepoort, Transvaal, South Africa.*

MOORE, J. PERRY, B.S., Ph.D. (Pennsylvania, 22, 30), Professor of Zoology, *University of Pennsylvania, Philadelphia, Pennsylvania.*

MOORTHY, V. N., B.Sc., M.B. (Bangalore, India, 26, 29), D.P.H. (Institute of Hygiene, Calcutta, 32), D.T.M. (School of Tropical Medicine, Calcutta, 33), Dr. P.H. (Johns Hopkins, 38), *Kankanally, South Cross Road, Basavangudy P. O., Bangalore, Mysore State, South India.*

MOREHOUSE, NEAL F., B.S. (Kansas State College, 33), M.S. (Iowa State College, 35), Parasitologist, Research Department, *Doctor Salsbury's Laboratory, Charles City, Iowa.*

MORELAND, GEORGE E., B.S. (Greenville College, 21), M.S. (Michigan, 29), Ph.D. (Cornell, 38), Professor of Biology, *Greenville College, Greenville, Illinois.*

MORRIS, SAMUEL, B.S. (Pennsylvania State College, 22), M.A., Ph.D. (Pennsylvania, 30, 35), Assistant Professor and Head of Department of Biology, *Scranton-Keystone Junior College, La Plume, Pennsylvania.*

MUELLER, JUSTUS F., A.B. (Johns Hopkins, 23), M.A., Ph.D. (Illinois, 26, 28), Associate Professor of Forest Zoology, *New York State College of Forestry, Syracuse, New York.*

MUGRAGE, EDWARD R., A.B., A.M. (Denver, 07, 08), M.D. (Colorado, 13), Professor of Clinical Pathology, *School of Medicine, University of Colorado, Denver, Colorado.*

MUKERJI, ARUN KUMAR, M.B. (Calcutta, India, 18), Assistant Research Worker, Department of Helminthological Research, *Calcutta School of Tropical Medicine, Calcutta, India.*

NELSON, E. CLIFFORD, A.B., M.A. (Colorado, 29, 30), Sc.D. (Johns Hopkins, 33), Assistant Professor of Zoology, *University of Maine, Orono, Maine.*

NELSON, THURLOW C., B.S. (Rutgers, 13), Ph.D. (Wisconsin, 17), Professor of Zoology, Rutgers University, Biologist, *New Jersey Board of Shellfisheries, New Brunswick, New Jersey.*

NICHOLS, THEODORE EARL, D.V.M., M.S. (Ohio State, 21, 33), Assistant Veterinarian, Bureau of Animal Industry, *U. S. Department of Agriculture, 5041 West Broad St., Columbus, Ohio.*

NICKEL, HANNAH S., B.S. (Louisiana State, 31), M.S. (Tulane, 38), Parasitologist, *Mississippi State Board of Health, Jackson, Mississippi.*

NOBLE, ALDEN E., A.B. (Ohio Wesleyan, 23), M.S. (Ohio State, 24), Ph.D. (California, 31), Professor of Zoology, *College of the Pacific, Stockton, California.*

NOBLE, ELMER R., A.B., M.A., Ph.D. (California, 31, 33, 36), Assistant Professor of Biology, *Santa Barbara State College, Santa Barbara, California.*

NOLAN, MABELLE ORLEMAN (MRS.), B.A. (Smith College, 22), M.A. (American University, 30), Assistant Nematologist, *National Institute of Health, Washington, District of Columbia.*

NOLAND, LOWELL EVAN, B.A. (DePauw, 17), M.A., Ph.D. (Wisconsin, 21, 24), Professor of Zoology, *University of Wisconsin, Madison, Wisconsin.*

NOLF, LUTHER O., B.S., M.S. (Kansas State College, 26, 29), Sc.D. (Johns Hopkins, 31), Associate in Zoology, *University of Iowa, Iowa City, Iowa.*

ODLAUG, THERON O., A.B. (Luther College, Iowa), M.S. (New York University), Department of Biology, *Billings Polytechnic Institute, Polytechnic, Montana.*

OFFUTT, EDWARD PREBLE, JR., B.A. (Dartmouth College, 35), Ph.D. (Rice Institute, 39), Assistant in Bacteriology, *University of Rochester School of Medicine and Dentistry, Rochester, New York.*

OLIVIER, LOUIS, JR., B.S. (Michigan, 36), M.S. (New York University, 38), Graduate Assistant, *New York University, University Heights, New York.*

OLSEN, O. WILFORD, B.A. (Brigham Young University, 29), M.A., Ph.D. (Minnesota, 31, 36), Assistant Parasitologist, Zoological Division, U. S. Bureau of Animal Industry, *care of Texas Experiment Station, Angleton, Texas.*

O'ROKE, EARL C., A.B., A.M. (Kansas, 12, 16), Ph.D. (California, 29), Associate Professor of Forest Zoology, *University of Michigan, Ann Arbor, Michigan.*

OSBORN, HERBERT, B.S., M.S., D.Sc. (Hon.) (Iowa State College, 79, 80, 16), LL.D. (Hon.) (Pittsburgh, 30), LL.D. (Hon.) (Ohio State University, 30), Emeritus Professor of Zoology and Entomology, *Ohio State University, Columbus, Ohio.*

OSBURN, RAYMOND C., B.S., M.S. (Ohio State, 98, 00), Ph.D. (Columbia, 06), Professor and Chairman of Department of Zoology and Entomology, *Ohio State University, Columbus, Ohio.*

OSORNO, ERNESTO, M.D. (National University, Bogota, Colombia, South America), Department of Tropical Medicine, *Harvard University Medical School, Boston, Massachusetts.*

OTT, GEORGE LEWIS, B.A., Ph.D. (Wisconsin, 31, 37), Director of Research, *Herbert A. Nieman and Company, Thiensville, Wisconsin.*

OTTO, G(ILBERT) F., A.B. (Kalamazoo College, 26), M.S. (Kansas State College, 27), Sc.D. (Johns Hopkins, 29), Associate in Helminthology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

OWEN, WILLIAM B., A.B. (Kentucky, 27), A.M., Ph.D., (Minnesota, 29, 36), Assistant Professor of Zoology, *University of Wyoming, Laramie, Wyoming.*

PACKCHANIAN, ARDZROONY, M.S., Ph.D. (Michigan, 30, 33), Protozoologist, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

PARMAN, DANIEL C., B.S.A. (Tennessee, 11), Associate Entomologist, Bureau of Entomology and Plant Quarantine, *U. S. Department of Agriculture, Box 509, Uvalde, Texas.*

PAUL, ALLARD ANTHONY, B.S. (Albright College, 30), Ph.D. (New York University, 38), Instructor, *College of the City of New York, New York, New York.*

PAYNE, GEORGE C., A.B. (Missouri, 10), M.D. (Cornell, 12), D.P.H. (Johns Hopkins, 23), Field Director, International Health Division, *Rockefeller Foundation, Box 519, San Juan, Puerto Rico.*

PEARSE, ARTHUR S., B.S., M.A. (Nebraska, 00, 04), Ph.D. (Harvard, 08), Professor of Zoology, *Duke University, Durham, North Carolina.*

PENNER, LAWRENCE R., A.B., A.M. (Kansas, 34, 36), Teaching Assistant, Department of Zoology, *University of Minnesota, Minneapolis, Minnesota.*

PEREIRA, CLEMENTE, M.D. (São Paulo, Brazil, 31), Privatdocent, Medical Zoology and Parasitology, Veterinary Faculty, (São Paulo, 35), Head of Department of Parasitology, *Instituto Biologico, P. O. Box 2821, São Paulo, Brazil, South America.*

PEREZ-VIGUERAS, ILDEFONSO, Graduate (Havana Veterinary School, 13), *Calle 5, Rep. Almendares, Marianao, Cuba.*

PHILIP, CORNELIUS BECKER, B.S. (Nebraska, 23), M.S., Ph.D. (Minnesota, 25, 31), Medical Entomologist, *Rocky Mountain Laboratory, U. S. Public Health Service, Hamilton, Montana.*

PIGMAN, ELBRIDGE G., D.V.M. (Kansas City Veterinary College, 13), Assistant Veterinarian, Bureau of Animal Industry, *U. S. Department of Agriculture, Rt. 3, Box 932, Houston, Texas.*

PORTER, ANNIE, D.Sc. (University College, London, 10), F.R.S. (South Africa), Honorary Parasitologist to the *Zoological Society of London, Regent's Park, London, N.W. 8, England.*

PORTER, DALE A., A.B. (Kalamazoo College, 30), M.S. (Kansas State College, 32), Sc.D. (Johns Hopkins, 35), Associate Parasitologist, Regional Laboratory, Animal Disease Research, Bureau of Animal Industry, *U. S. Department of Agriculture, P. O. Drawer 952, Auburn, Alabama.*

POTE, THOMAS B., D.V.S. (McGill, 92), M.D. (Washington University, St. Louis, 02), Lecturer in Pathology, Washington University Medical School, *4925 Park View Place, St. Louis, Missouri.*

PRICE, EMMETT W., D.V.M., Ph.D. (George Washington, 18, 35), M.S. (American University, 31), Assistant Chief, Zoological Division, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

RANKIN, JOHN STEWART, JR., A.B., M.A. (Wesleyan, 33, 34), Ph.D. (Duke, 36), Instructor in Biology, *Amherst College, Amherst, Massachusetts.*

RATCLIFFE, HERBERT L., B.S., M.S. (Emory, 25, 26), Sc.D. (Johns Hopkins, 28), Assistant Pathologist, Zoological Society of Philadelphia, Associate in Comparative Pathology, *Medical School, University of Pennsylvania, Philadelphia, Pennsylvania.*

REARDON, LUCY, A.B., M.A. (George Washington), *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

REDMOND, WILLIAM B., A.B., M.S. (Emory, 27, 28), Ph.D. (Chicago, 37), Assistant Professor of Biology, Emory University, *Box 534, Emory University, Georgia.*

REES, CHARLES W., B.S. (Utah College, 13), A.M., Ph.D. (California, 20, 21), Senior Protozoologist, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

REFUERZO, PEDRO G., D.V.M. (University of the Philippines), Instructor in Veterinary Medicine, *College of Veterinary Science, University of the Philippines, Manila, Philippine Islands.*

RENDTORFF, ROBERT C., A.B., M.S. (Illinois, 37, 39), Graduate Student, *Department of Zoology, University of Illinois, Urbana, Illinois.*

REYNOLDS, BRUCE D., B.S. (Virginia, 20), Sc.D. (Johns Hopkins, 23), Associate Professor of Biology, *University of Virginia, Charlottesville, Virginia.*

RICHARDSON, LAURENCE ROBERT, B.Sc., M.Sc., Ph.D. (McGill, 31, 33, 35), Demonstrator, Department of Zoology, *McGill University, Montreal, Canada.*

RIETZ, JOHN HARRISON, D.V.M., M.S. (Ohio State, 03, 29), Associate Professor of Animal Pathology, West Virginia University, and Animal Pathologist, *West Virginia Experiment Station, Morgantown, West Virginia.*

RILEY, WILLIAM A., B.S., Sc.D. (Hon.) (DePauw, 97, 26), Ph.D. (Cornell, 03). Professor and Chief of Division of Entomology and Economic Zoology, *University of Minnesota, Minneapolis, Minnesota.*

RITCHIE, LAWRENCE S., A.B. (Grand Island College, 28), M.A., Ph.D. (Northwestern, 30, 36), Instructor in Biology, *Woman's College of University of North Carolina, Greensboro, North Carolina.*

ROBERTS, RAIFORD ASHLEY, B.S. (Texas Agricultural and Mechanical College, 26), M.S. (Iowa State College, 28), Entomologist and Project Leader, Mormon Cricket Control, *Bureau of Entomology and Plant Quarantine, 702 Newhouse Bldg., Salt Lake City, Utah.*

RODRIGUEZ-MOLINA, RAFAEL, B.S. (Puerto Rico, 23), M.D. (Medical College of Virginia, 26), Sc.D. (Columbia, 35), Associate in Parasitology, *School of Tropical Medicine, San Juan, Puerto Rico.*

ROSENBERG, LAUREN EMERY, B.S. (Knox College, 30), M.A., Ph.D. (California, 33, 35), Instructor in Zoology and Junior Zoologist, Experiment Station, *College of Agriculture, University of California, Davis, California.*

ROUDABUSH, ROBERT LEE, A.B. (Lebanon Valley College, 31), M.S., Ph.D. (Iowa State College, 32, 36), Head, Microscope Slide Department, *Ward's Natural Science Establishment, 302 North Goodman St., Rochester, New York.*

ROVIROSA, GUSTIVO A., M.D. (Facultad de Medecina de Puebla, Colegio del Estado, Mexico, 33), *Zamora, 174, Mexico, Distrito Federal, Mexico.*

ROZEBOOM, LLOYD E., S.B. (Iowa State College, 31), Sc.D. (Johns Hopkins, 34), Associate in Entomology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

RUHE, DAVID S., B.S., M.S. (Michigan State College, 36, 37), Medical Student, *Temple University Medical School, Broad and Ontario Sts., Philadelphia, Pennsylvania.*

SANDGROUND, JACK H., B.Sc., M.Sc. (South Africa, 19, 20), Sc.D. (Johns Hopkins, 25), Research Staff, Biological Division, The Lilly Research Laboratories, *Eli Lilly and Company, Indianapolis, Indiana.*

SARLES, MERRITT PARDEE, B.S. (Wesleyan, 25), Sc.D. (Johns Hopkins, 29), Assistant Parasitologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Beltsville, Maryland.*

SAUNDERS, LESLIE GALE, B.S.A., M.Sc. (McGill, 20, 21), Ph.D. (Cambridge, England, 24), Assistant Professor of Zoology, *University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

SAWITZ, WILLI, M.D. (Rostock, Germany, 19), Instructor in Parasitology, Department of Tropical Medicine, *Tulane University School of Medicine, New Orleans, Louisiana.*

SAWYER, WILBUR A., A.B., M.D. (Harvard, 02, 06), Director, International Health Division, Rockefeller Foundation, *29 Ferndale Drive, Hastings-on-Hudson, New York.*

SCHELL, MARGARET WOOD, A.B., M.A., Ph.D. (California, 24, 25, 30), Assistant Professor of Zoology, *University of Utah, Salt Lake City, Utah.*

SCHOR, IRVING MURRAY, B.S. (New York University, 33), M.S. (Virginia), *Medical College of Virginia, Richmond, Virginia.*

SCHWARTZ, BENJAMIN, A.B. (College of the City of New York, 11), A.M. (Columbia, 13), Ph.D. (George Washington, 20), Chief, Zoological Division, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

SCOTT, J. ALLEN, B.A., M.A. (Wesleyan, 22, 24), Sc.D. (Johns Hopkins, 27), Helminthologist, Ministry of Health, Venezuelan Government, *Direccion de Malariologia, Apartado 1509, Caracas, Venezuela, South America.*

SCOTT, JOSEPH M., B.S. (Mount Union College, 13), Sc.D. (Johns Hopkins, 23), Professor of Biology, *Mount Union College, Alliance, Ohio.*

SCOTT, JOHN W., A.B., A.M. (Missouri, 96, 97), Ph.D. (Chicago, 04), Secretary and Director, Wyoming Game and Fish Commission, *400 West 27th St., Cheyenne, Wyoming.*

SEMRAD, JOSEPH E., Ph.B. (Creighton, 27), M.S. (St. Louis, 31), Ph.D. (Northwestern, 35), Associate Professor of Biology, *Loyola University, Chicago, Illinois.*

SHATTUCK, GEORGE CHEEVER, A.B., M.D., A.M. (Hon.) (Harvard, 01, 05, 19), Clinical Professor of Tropical Medicine, *Harvard University Medical School, 25 Shattuck St., Boston, Massachusetts.*

SHELDON, ALBERT JOHN, B.A., M.A. (Buffalo, 33, 34), Sc.D. (Johns Hopkins, 37), Instructor in Public Health, *School of Medicine, University of North Carolina, Chapel Hill, North Carolina.*

SHIELDS, RANDOLPH J., A.B. (Washington and Lee), M.D. (Virginia Medical College), Dean, *School of Medicine, Cheeloo University, Tsinan, Shantung, China.*

SIMMS, BENNETT T., D.V.M. (Alabama Polytechnic Institute, 11), *Regional Animal Disease Research Laboratory, Auburn, Alabama.*

SMITH, ROBB, *523 Seventh Ave. West, Ashland, Wisconsin.*

SMITH, SEPTIMA C., A.B., A.M. (Texas, 22, 23), Sc.D. (Johns Hopkins, 27), Associate Professor of Zoology, *University of Alabama, Tuscaloosa, Alabama.*

SOMMERMEYER, VIOLA LOUISE, B.S. (Minnesota, 28), Owner and Director, Clinical Laboratory, *301 Medico Dental Bldg., San Diego, California.*

SOPER, FRED L., A.B., M.S. (Kansas, 14, 16), M.D. (Rush Medical College, 18), D.P.H. (Johns Hopkins, 25), Field Staff, International Health Division, Rockefeller Foundation, *Caixa Postal 89, Rio de Janeiro, Brazil, South America.*

SPINDLER, L(LOYD) A., B.S., M.S. (Kansas State College, 26, 27), Sc.D. (Johns Hopkins, 29), Associate Zoologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

STABLER, ROBERT M., A.B. (Swarthmore College, 27), Sc.D. (Johns Hopkins, 31), Instructor in Zoology, *University of Pennsylvania, Philadelphia, Pennsylvania.*

STAFFORD, E(THELBERT) W., B.S.A. (Toronto, 09), M.S. (Mississippi Agricultural and Mechanical College, 14), Associate Professor of Zoology and Entomology, *Mississippi State College, State College, Mississippi.*

STAUBER, LESLIE ALFRED, B.S., M.S. (Rutgers, 29, 30), Ph.D. (Chicago, 37), Assistant Biologist, Oyster Investigation Laboratory, *New Jersey Agricultural Experiment Station, Bivalve, New Jersey.*

STEINER, GOTTHOLD, Ph.D. (Bern, Switzerland, 10), Senior Nematologist, *Bureau of Plant Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

STEWART, MORRIS ALBION, B.S. (New Hampshire, 24), M.S., Ph.D. (Cornell, 26, 29), Assistant Entomologist, California Agricultural Experiment Station, Assistant Professor of Entomology, *University of California, Davis, California.*

*STILES, CHARLES W., A.M., Ph.D. (Leipzig, Germany, 90), M.D. (Paris, France, 96), M.S. (Hon.), Sc.D. (Hon.) (Wesleyan, 96, 07), LL.D. (Hon.) (North Carolina, 12), M.D. (Hon.) (Richmond, 13), Sc.D. (Hon.) (Yale, 15), *Smithsonian Institution, Washington, District of Columbia.*

STOLL, NORMAN R., B.S. (Mount Union College, 15), M.S. (Michigan, 18), Sc.D. (Johns Hopkins, 23), Associate Member, Department of Animal and Plant Pathology, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

STRONG, RICHARD P., Ph.B., Sc.D. (Hon.) (Yale, 93, 14), M.D. (Johns Hopkins, 97), Sc.D. (Hon.) (Harvard, 16), Professor of Tropical Medicine, *Harvard University Medical School, Boston, Massachusetts.*

STUNKARD, HORACE W., B.S., Sc.D. (Hon.) (Coe College, 12, 37), A.M., Ph.D. (Illinois, 14, 16), Professor and Head of Department of Biology, *New York University, University Heights, New York, New York.*

SUMMERS, WILLIAM A., A.B., M.S. (Illinois, 35, 36), Department of Tropical Medicine, *Tulane University, New Orleans, Louisiana.*

SVENSSON, RUTH M., M.D. (Royal University of Uppsala, Sweden), *Ullraher, Uppsala Friedenreich, Sweden.*

SWARTZWELDER, JOHN CLYDE, B.S. (Massachusetts State College, 33), M.S., Ph.D. (Tulane, 34, 37), Instructor in Parasitology and Medical Entomology, Department of Preventive Medicine and Public Health, *Louisiana State University, Medical Center, New Orleans, Louisiana.*

SWEET, WINFIELD CAREY, S.B. (Colgate, 13), M.D. (Chicago, 17), C.P.H., D.P.H. (Johns Hopkins, 28, 31), Field Director, International Health Division, Rockefeller Foundation, *Hotel Cecil, Delhi, India.*

SWEZY, WILLIAM W., B.S. (Mount Union College, 30),, Sc.D. (Johns Hopkins, 33), Professor of Biology, *Defiance College, Defiance, Ohio.*

TALBOT, S. BENTON, B.S. (Davis and Elkins College, 24), B.S.S. (Bowling Green Business University, 25), Sc.D. (Johns Hopkins, 33), Professor of Biology, *Davis and Elkins College, Elkins, West Virginia.*

TALIAFERRO, WILLIAM HAY, S.B. (Virginia, 15), Ph.D. (Johns Hopkins, 18), Professor of Parasitology, Chairman, Department of Bacteriology and Parasitology, and Dean, Division of Biological Sciences, *University of Chicago, Chicago, Illinois.*

TENBROECK, CARL, A.B. (Illinois, 08), M.D. (Harvard, 13), Member and Director, Department of Animal and Plant Pathology, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

TERZIAN, LEVON A., B.S., M.S. (Pennsylvania, 36, 37), Assistant in Protozoology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

THOMAS, ALICE, A.B. (Woman's College of the University of North Carolina, 35), Technician for Malaria Survey Division, North Carolina Board of Health, *615 Wills Forest St., Raleigh, North Carolina.*

THOMAS, LYELL JAY, B.S. (Fargo, 17), M.S., Ph.D. (Illinois, 21, 23), Assistant Professor of Zoology, *University of Illinois, Urbana, Illinois.*

THRELKELD, WILLIAM L., A.B. (Kentucky, 15), A.M., Ph.D. (Virginia, 29, 34), Assistant Parasitologist, *Virginia Agricultural Experiment Station, Blacksburg, Virginia.*

TODD, ARLIE, A.B. (Kalamazoo College, 37), M.S. (Kansas State College, 37), Assistant Instructor in Zoology, *University of Nebraska, Lincoln, Nebraska.*

TIDD, WILBUR M., A.B., M.S., Ph.D. (Ohio State, 23, 29, 37), Instructor in Zoology and Entomology, *Ohio State University, Columbus, Ohio.*

TOWNSEND, ELSIE WHITE, A.B., M.A. (Michigan, 22, 27), Instructor in Zoology, *Wayne University, Detroit, Michigan.*

TRAGER, WILLIAM, B.S. (Rutgers, 30), M.A., Ph.D. (Harvard, 31, 33), Assistant, Department of Animal and Plant Pathology, *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

TRAVIS, BERNARD V., B.S. (Colorado State College, 30), M.S., Ph.D. (Iowa State College, 33, 37), Assistant Entomologist, U. S. Department of Agriculture, *Box 655, New Smyrna, Florida.*

TSUCHIYA, HIROMU, A.B. (Missouri, 13), Sc.D. (Johns Hopkins, 30), Instructor in Bacteriology, Immunology and Public Health, and Parasitologist to Barnes Hospital, *Washington University School of Medicine, St. Louis, Missouri.*

TYZZER, ERNEST E., Ph.B., A.M., Sc.D. (Hon.) (Brown, 94, 98, 35), M.D. (Harvard, 02), Professor of Comparative Pathology, *Harvard University Medical School, Boston, Massachusetts.*

VAN CLEAVE, HARLEY JONES, B.S. (Knox College, 09), M.S., Ph.D. (Illinois, 10, 13), Professor and Acting Head of Department of Zoology, *University of Illinois, Urbana, Illinois.*

VAN DEN BERGHE, LOUIS, M.D., D.T.M. (Brussels, Belgium, 31, 32), Professor, *Institut de Medecine Tropicale Prince Leopold, 155 Rue Nationale, Anvers, Belgium.*

VAN VOLKENBERG, HORATIO L., B.S., D.V.M., M.S. (Cornell), *807 East 29th St., Bryan, Texas.*

VARGAS, LUIS, M.D. (National University of Mexico, 29), National Faculty of Medicine, *Calle de la Escuela Medico Militar No. 20, Mexico, Distrito Federal, Mexico.*

VAZ, ZEFERINO, *Instituto Biologio de São Paulo, São Paulo, Brazil, South America.*

VENARD, CARL E., B.A., M.S. (Ohio State, 31, 32), Ph.D. (New York University, 36), Instructor in Zoology, *Ohio State University, Columbus, Ohio.*

VERGEER, TEUNIS, A.B. (Calvin College, 26), M.S., Ph.D. (Michigan, 28, 32), Professor of Biology, *Hope College, Holland, Michigan.*

VISSCHER, J. PAUL, A.B. (Hope College, 17), A.M., Ph.D. (Johns Hopkins, 20, 24), Professor and Head of Department of Biology, *Western Reserve University, Cleveland, Ohio.*

VOGEL, HANS, Ph.D., M.D., *Tropeninstitut, Bernard Nochstrasse 74, Hamburg 4, Germany.*

VON BRAND, THEODOR, Ph.D. (Munich, Germany, 22), M.D. (Erlangen, Germany, 28), Professor of Biology, *Barat College, Lake Forest, Illinois.*

WALKER, J(OSEPH) HENRY, B.S. (Georgia, 23), M.S. (Illinois, 29), Ph.D. (Tulane, 37), Associate Professor of Zoology, *University of Alabama, University, Alabama.*

WALLACE, F(RANKLIN) G(ERHARD), B.A. (Carleton College, 28), M.A., Ph.D. (Minnesota, 30, 33), Instructor, Department of Zoology, *University of Minnesota, Minneapolis, Minnesota.*

WALTON, ARTHUR CALVIN, B.A., M.A. (Northwestern, 14, 15), Ph.D. (Illinois, 23), Professor and Chairman, Department of Biology, *Knox College, Galesburg, Illinois.*

WANTLAND, WAYNE W., B.S., M.A., Ph.D. (Northwestern, 30, 32, 35), Department of Biology, *Stephens College, Columbia, Missouri.*

*WARD, HENRY B., A.B., Sc.D. (Hon.) (Williams, 85, 21), A.M., Ph.D. (Harvard, 92), Sc.D. (Hon.) (Cincinnati, 20), LL.D. (Hon.) (Oregon, 32), LL.D. (Hon.) (Nebraska, 35), Emeritus Professor of Zoology, University of Illinois, *1201 West Nevada St., Urbana, Illinois.*

WARD, JAMES W., A.B., A.M. (Alabama, 29, 32), M.S. (Mississippi State College, 31), Assistant Professor of Zoology and Entomology, *Mississippi State College, State College, Mississippi.*

WARREN, ANDREW J., M.D. (Tulane), C.P.H. (John Hopkins), Assistant Director, International Health Division, *Rockefeller Foundation, 20 rue de la Baume, Paris (VIII), France.*

WARREN, HERBERT STETSON, B.S. (College of the City of New York, 11), M.A. (Columbia, 20), Ph.D. (Stanford, 26), Instructor in Anatomy, *Hahnemann Medical College, Philadelphia, Pennsylvania.*

WEATHERS, CURTIS L., B.A. (Wake Forest College, 20), M.A. (North Carolina, 25), M.A. (Columbia, 27), Assistant Professor of Biology, *Long Island University, 300 Pearl St., Brooklyn, New York.*

WEHR, EVERETT ELMER, B.S. (Idaho, 18), M.S.A. (California, 21), Ph.D. (George Washington, 35), Associate Zoologist, *Bureau of Animal Industry, U. S. Department of Agriculture, Washington, District of Columbia.*

WEINMAN, DAVID, A.B. (Columbia, 29), D.T.M., Doctor of Malariology, M.D. (Paris, France, 33, 34, 35), Assistant in Comparative Pathology and Tropical Medicine, Medical School and *School of Public Health, Harvard University, Boston, Massachusetts.*

WELLER, THOMAS H., A.B., M.S. (Michigan, 36, 37), Medical Student, Harvard University Medical School, *1130 Fair Oaks, Ann Arbor, Michigan.*

WENRICH, DAVID HENRY, A.B., A.M. (Kansas, 11, 12), Ph.D. (Harvard, 15), Professor of Zoology, *University of Pennsylvania, Philadelphia, Pennsylvania.*

WEST, D. EVELYN, B.S. (Allegheny College, 28), Chief Microbiologist, *Bureau of Laboratories, State Department of Health, Box 1139, Hartford, Connecticut.*

WETZEL, RUDOLF, D.V.M., *Institute for Veterinary-Medical Parasitology and Zoology, Luisenstrasse 56, Berlin, Germany.*

WHARTON, GEORGE WILLARD, JR., B.S. (Duke, 35), Fellow, *Duke University, Durham, North Carolina.*

WHITENER, PAUL DOUGLAS, B.S. (Appalachian College, 35), Biology Teacher, *Cramerton High School, Cramerton, North Carolina.*

WHITLOCK, JOHN H., D.V.M. (Iowa State College, 34), M.S. (Kansas State College, 35), Assistant Professor of Veterinary Pathology, *Kansas State College, Manhattan, Kansas.*

WHITMORE, EUGENE R., B.S. (Wisconsin, 96), M.D. (Illinois, 99), D.P.H. (Johns Hopkins, 21), Ph.D. (Georgetown, 30), Professor of Parasitology and Pathology, Medical and Dental Schools, *Georgetown University, 2139 Wyoming Ave., N.W., Washington, District of Columbia.*

WICHTERMAN, RALPH, B.S. (Temple, 30), M.A., Ph.D. (Pennsylvania, 32, 36), Instructor in Biology, *Temple University, Philadelphia, Pennsylvania.*

WILLEY, CHARLES H., A.B., M.S., Ph.D. (New York University, 22, 24, 29), Assistant Professor of Biology, *New York University, University Heights, New York, New York.*

WILLIAMS, OWEN L., A.B. (Nebraska, 27), M.A., Ph.D. (California, 28, 32), Student, University of California, School of Medicine, *2001 Allston Way, Berkeley, California.*

WILMOTH, JAMES H., B.S. (Monmouth College, 32), M.S. (Kansas State College, 34), Graduate Assistant, *New York University, University Heights, New York, New York.*

WILSON, FRANCIS HENRY, B.S., M.S., Ph.D. (Cornell, 23, 25, 31), Associate Professor of Zoology, *Tulane University, New Orleans, Louisiana.*

WINFIELD, GERALD F., B.S. (Southern Methodist, 28), M.S. (Illinois, 29), Sc.D. (Johns Hopkins, 32), Professor of Biology, *Cheeloo University, Tsinan, Shantung, China.*

WOKE, PAUL A., B.S. (Ottawa College, Kansas, 30), B.S. (Kansas, 30), Sc.D. Johns Hopkins, 37), Assistant Entomologist, *Bureau of Entomology, U. S. Department of Agriculture, Beltsville, Maryland.*

WOLFSON, FRUMA, A.B., M.A. (Syracuse, 33, 34), Sc.D. (Johns Hopkins, 36), Research Fellow in Protozoology, *School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.*

WOOD, SHERWIN F., A.B. (California at Los Angeles, 31), M.A., Ph.D. (California, 33, 35), Instructor in Biology, Los Angeles City College, *855 N. Vermont Ave., Los Angeles, California.*

WOODHEAD, ARTHUR E., A.B. (Clark, 14), A.M., Ph.D. (Michigan, 26, 28), Associate Professor of Zoology, *University of Michigan, Ann Arbor, Michigan.*

WORTH, C. BROOKE, A.B. (Swarthmore College, 31), M.D. (Pennsylvania, 35), *Rockefeller Institute for Medical Research, Princeton, New Jersey.*

WOTTON, ROBERT M., A.B. (Columbia, 38), Graduate Student, Department of Bacteriology, *College of Physicians and Surgeons, Columbia University, New York, New York.*

WRIGHT, WILLARD H., D.V.M., Ph.D. (George Washington, 17, 35), M.S. (American University, 31), Senior Zoologist, *National Institute of Health, U. S. Public Health Service, Washington, District of Columbia.*

WU, KUANG, Ph.D. (Michigan, 33), Parasitologist, *Henry Lester Institute of Medical Research, 1320 Avenue Rd., Shanghai, China.*

YOKOGAWA, S., Department of Experimental Pathology and Parasitology, *Taihoku Imperial University, Taihoku, Formosa, Japan.*

YOUNG, BENJAMIN P., B.S. (Kansas, 08), Ph.D. (Cornell, 19), Acting Chairman, Department of Zoology, *Cornell University, Ithaca, New York.*

YOUNG, MARTIN DUNAWAY, B.S., M.S. (Emory, 31, 32), Sc.D. (Johns Hopkins, 37), Junior Zoologist, *U. S. Public Health Service, Box 1344, Columbia, South Carolina.*

YUTUC, LOPE M., D.V.M. (University of the Philippines, 24), Assistant Professor of Veterinary Medicine, *College of Veterinary Science, Manila, Philippine Islands.*

ZARAFONETIS, CHRIS JOHN DIMITER, A.B., M.S. (Michigan, 36, 37), Student, University of Michigan Medical School, *Michigan Union, Ann Arbor, Michigan.*